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Norman Schmidt

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flying machines

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CONTENTS

Introduction 3
General Instructions 4

INCREDIBLE DREAMS
1 Leonardo da Vinci 6
2 Beznier 10
3 Sir George Cayley 14
4 William Samuel Henson 18
5 Horatio Phillips 22
6 Samuel Pierpont Langley 27
7 Molt Taylor 32
8 Jim Bede 36

INCREDIBLE SIZE
9 Montgolfier balloon 40
10 Henri Giffard dirigible 44
11 Zeppelin airship 48
12 Goodyear blimp 52

INCREDIBLE ACHIEVEMENTS
13 Louis Bleriot 56
14 Spirit of St Louis 60
15 Gee Bee racer 64
16 X-15 Spaceplane 68
17 F4 Phantom 72
18 SR-71 Blackbird 76
19 Hawker Harrier 80
20 Voyager 84
21 Space Shuttle 90

Aeronautical Terms 93
Index 96

The advice and directions given in this book have been carefully checked, prior to printing, by the Author as well as the Publisher. Nevertheless, no guarantee can be given as to project outcome due to possible differences in materials and construction and the Author and Publisher will not be responsible for the results. The paper planes are modeled after historic or existing aircraft and their resemblance to any other models is purely coincidental.

introduction

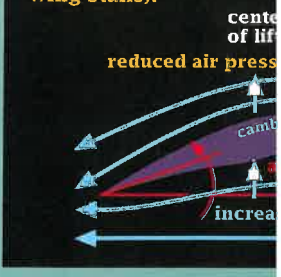
Before humans had actually taken to the skies by building machines that could imitate birds and other flying creatures, the idea of flight was truly incredible in both senses of the word: it was beyond belief and wonderful. Air, where flight took place, was invisible and etherial. How it could support machines and creatures made flight seem magical. Human beings wanted to share this mystical experience and from the dawn of history they have been obsessed with the idea of flying. The steps taken from dreaming about flight to actually taking to the skies resulted in some extraordinary inventions. The first steps were faltering, resulting in failure; others pushed flight forward in leaps and bounds until, late in the 19th century, successful human flight became a possibility. Finally in the 20th century, sustained and controlled flight became a reality. Now the resulting variety of aircraft found at today's airports, and their varied capabilities, is itself an incredible accomplishment.

NOTE The proportions of the aircraft represented in this book have been altered in the paper models to suit the paper medium, and they are not in scale to each other. Some of the paper models are fliers, while others are intended for static display only.

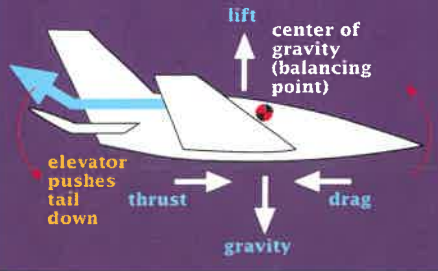
SOME BASICS

Flight is all about balance. There are four opposing forces acting on an airplane in exact balance: gravity/lift and thrust/drag. It is important that for flight an airplane's center of gravity lies just ahead of the wing's center of lift (most weight forward). The elevator, rudder, and ailerons are used to keep an airplane straight and level.

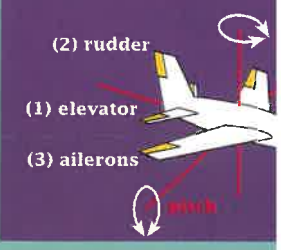
A wing produces lift in moves forward. (1) Cam surface creates a partia the wing. (2) Angle of a wing increases pressur wing. Every wing shape angle of attack for best beyond a certain angle wing stalls).



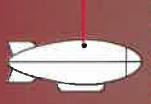
As an airplane moves forward the wings lift it into the air. To maintain the correct angle of attack the elevator must be angled upward slightly. This is called trimming (adjusting) for cruise. Changing the elevator angle also causes the plane to climb or dive.



An airplane tends to be ways. (1) Pitch: the elev up-and-down movement (2) Yaw: the rudder cont side movement. (3) Roll level by the ailerons in adjust (trim) a paper mo and level flight simply be part in the appropriate



displaying the models



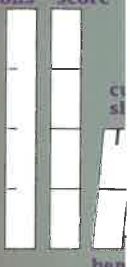
suspend from thread fastened through a small hole pierced at the balancing point

OR

insert into display stand made from a strip of card

To make stand:

mark 4 equal divisions score



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photocopies (100%)
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and cut opening
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assembly. *Keep*
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h piece.

If you have not cut paper with a craft knife, begin by making some practice cuts. In pencil draw some squares, triangles, and circles of various sizes on index card stock and cut them out. For straight cuts use a steel edged ruler to guide the knife; make freehand cuts for curved lines. Always cut by drawing the knife towards you and away from the hand used to hold the paper. Continue to practice until you are comfortable with the tools.

Use a sharp craft knife (e.g. an X-acto knife with a #11 blade) on a suitable cutting surface (e.g. Olfa cutting mat). Practice cutting precisely on the line. Always keep the blade sharp.

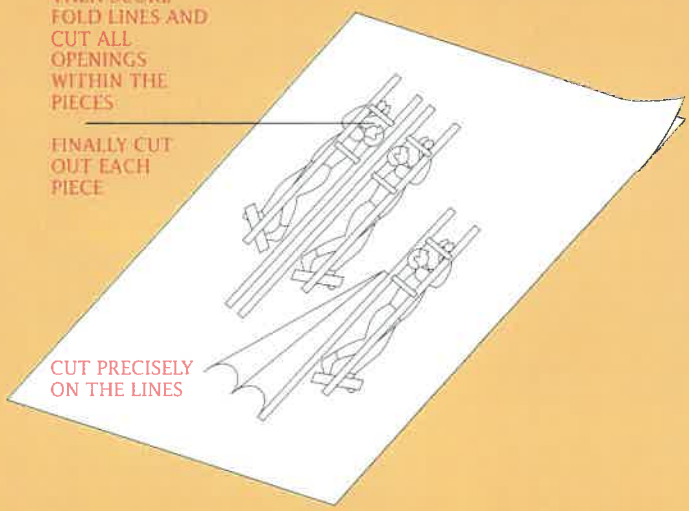
NOTE For all the cut-out pieces, the side that faces up for cutting will be outward or upward facing on the finished model. This is important for aesthetic and aerodynamic reasons because of the burr on the edges due to cutting.

NON-FLYING MODELS

FIRST build the main parts

Each model consists of several main parts built up of smaller pieces. Follow the sequence shown in the exploded view for each model. Begin with the number one piece, adding the other smaller pieces on each side to complete the larger part. *Align pieces carefully.* Take note of the bent-over tabs.

Stick glue (e.g. Uhu Color Stic), white craft glue, or wood-type model airplane glue can be used. However, it is easier to manage the drying time and reduce warpage with stick glue.


FIRST TACK-GLUE PHOTOCOPY OF THE LAYOUT SECTION TO CARD USING LOW-TACK GLUE (APPLY TO BACKSIDE OF PHOTOCOPY)
THEN SCORE FOLD LINES AND CUT ALL OPENINGS WITHIN THE PIECES
FINALLY CUT OUT EACH PIECE
CUT PRECISELY ON THE LINES

Caution:
To avoid injury, never fly a paper air toward another person.

When building up the main parts in layers, apply glue to the entire *smaller* surface to be fastened to a larger one. Press pieces firmly together. Continue until the entire main part is completed.

Lay the assembled parts flat between clean sheets of paper underneath a weight (some heavy books) until the glue is sufficiently set. This will take between 30 and 45 minutes for stick glue, and several hours for white glue.

When the glue is dry add decoration and color to the various main parts of the model before final assembly, if desired.

NOTE If you use felt tipped markers, be sure to use non-toxic ones and work in a well ventilated area.

SECOND put it all together

Apply glue to the various parts or tabs as shown in the instructions for each model. Align parts carefully and press them together to complete the model.

THIRD displaying paper models

For static display, build stands out of index card, or suspend models from a thread, if desired (see p 3). For suspending a model, find the point on the model where it balances and hangs straight and level. Pierce a small hole at this point using a needle. Insert a thread to suspend the model. Models can be suspended independently or they can be assembled into a mobile.

FLYING MODELS

FIRST build fuselage

Build the fuselage following the same procedures described above for building the main parts of the non-fliers.

SECOND wings for flight

Symmetry is essential in wings. Align wing parts carefully. Special care must be taken in those wings consisting of two halves. Temporarily align the halves using masking tape until the joining piece has been glued in place.

On models that require it, the dihedral angle (upward slanting of wings from center to tips) must be adjusted while the parts are being assembled (before the glue is set). Use the angle guide given with the model for details. If stick glue is used, simply prop up the wings at the tips until the glue has set. If white glue (or model glue) is used, drying the wings is complicated. Some means must be devised to keep each wing from warping while maintaining the dihedral angle.

When the glue is ration and color t main parts of the final assembly, if

THIRD put it all to

Apply glue to the be that join the wings stabilizer to the fus wings and stabilize Press glued parts to *placement carefully plane from the top, the back.* **Symmetr ness in the compl essential.**

FOURTH camber t

This is a critical step the wings gives the to generate aerodyn Holding a wing at th thumb and forefing hands, gently mass to give the upper su convex curvature o carefully from the w ward the tip and ba sure the left and rig the same amount o kinking the paper. S tions for each mode amount of camber.

FIFTH test fly

The paper plane mu trimmed (adjusted) perform satisfactor

SIXTH fly for fun

Paper planes perfo doors in a light bre open spaces, away tions and traffic.

LEONARDO
ornithopter

non-flying model

DREAMS

EXPLODED

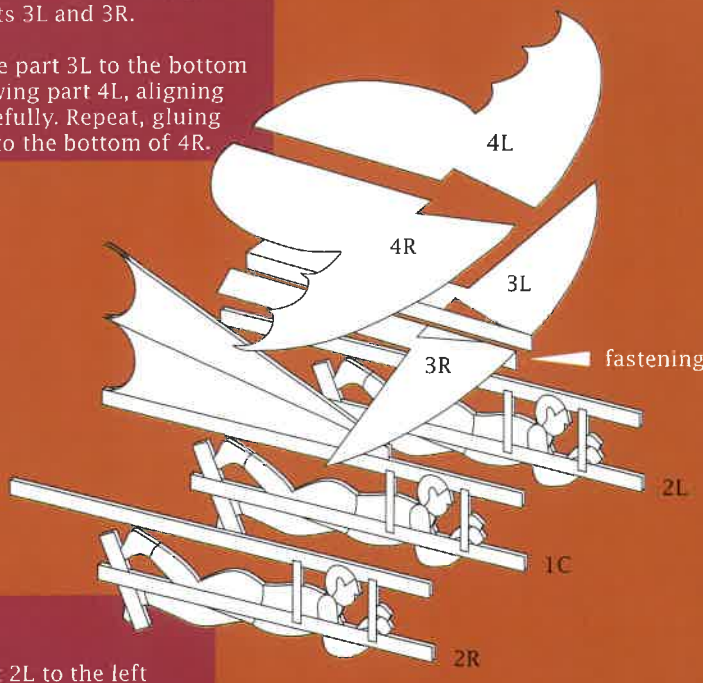
1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on parts 3L and 3R.

Glue part 3L to the bottom of wing part 4L, aligning carefully. Repeat, gluing 3R to the bottom of 4R.

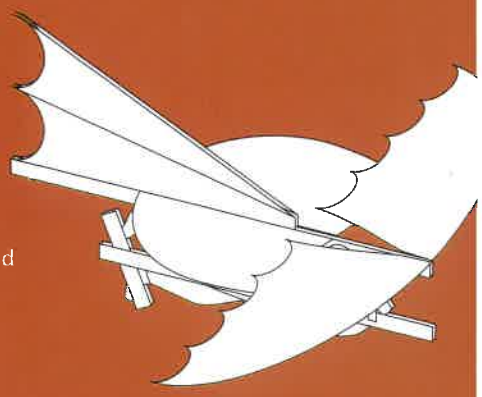


3

On the left, part 4L to t center part the right, gl part 4R to t center part

4

Glue part 2L to the left side of center part 1C, aligning carefully. Repeat on the right, gluing part 2R to center part 1C.



the finished aircraft

PIECES

leonardo

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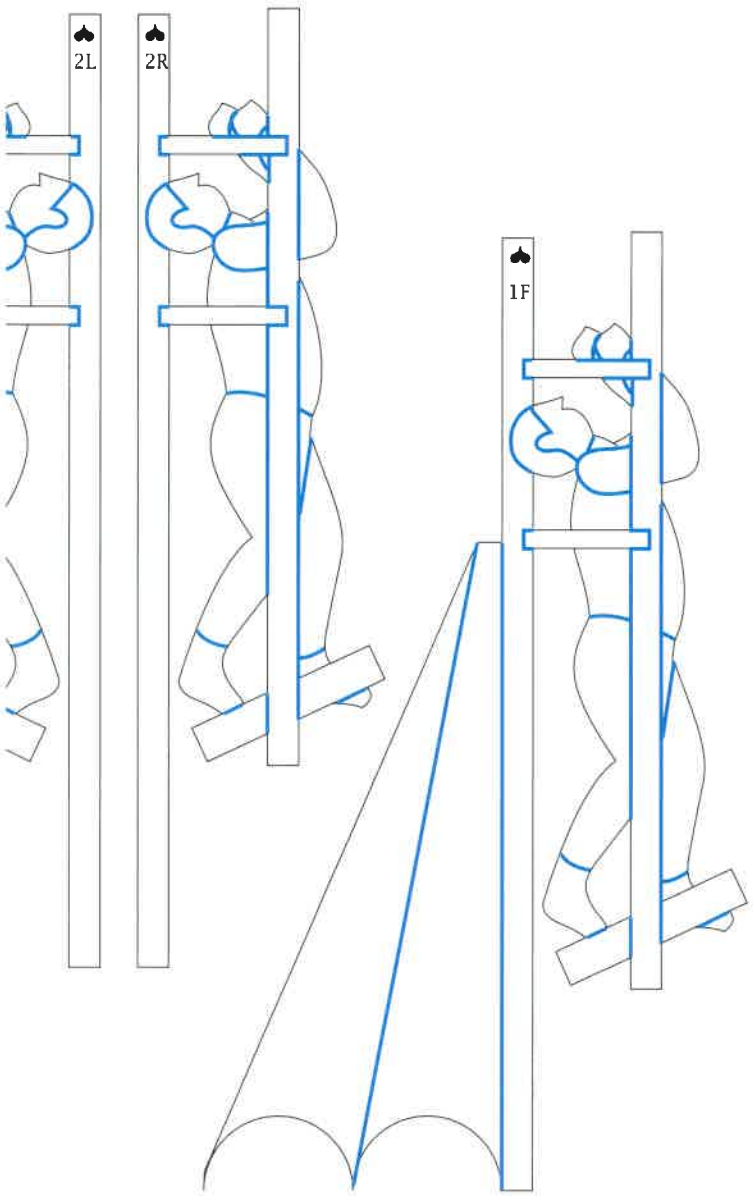
ed.
es as guides for adding details to the aircraft.
ont edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



Leonardo da Vinci (1452-1519) was fascinated by many kinds of natural forms, and this led him to make notes and sketches of plants, animals, birds, and human beings, filling nearly 6000 pages. In fact, he was interested in so many things that during his lifetime he worked at painting, sculpture, architecture, engineering, botany, geology, astronomy, anatomy, geography, armament design, and aviation. He was also a musician, singing and performing on instruments of his own invention. His accomplishments were incredible.

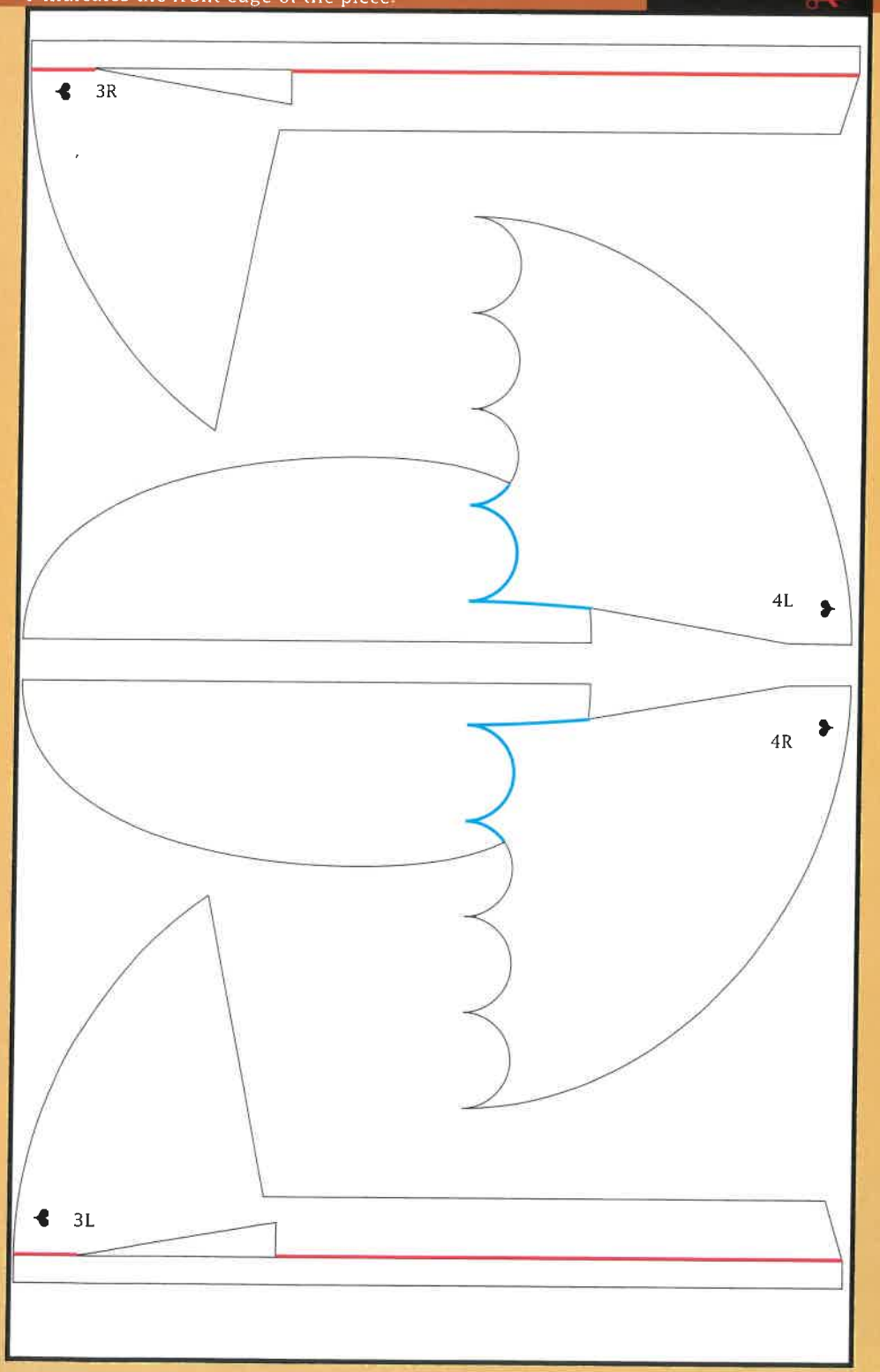
Because of his interest in the mechanics of things, Leonardo observed birds in flight, making many sketches of birds' wings in various positions. He thought that the action of birds' wings could be duplicated mechanically in a flying machine powered by a human, much as one peddles a bicycle. He made drawings of various wing-flapping machines (called ornithopters) to be built of wood, with the pilot in a prone or upright position on a ladder-like frame. Peddles were mechanially connected to wings that were made of cloth stretched on a frame.

Unfortunately, the true nature of bird flight was clouded by the fact that birds flap their wings. Flight

LEONARDO PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



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Moving the wings i
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hawks, eagles, and
perfectly well with
wingbeat.

Although Leonardo
the complexity of b
the dual function o
ornithopters don't
People have built th
plans. He did not h
understanding of th
between lift, drag, v
power to give his m
shape and proporti
for flight.

Human powered fli
achieved until 1977
with an ornithopter
Paul McGready's sci
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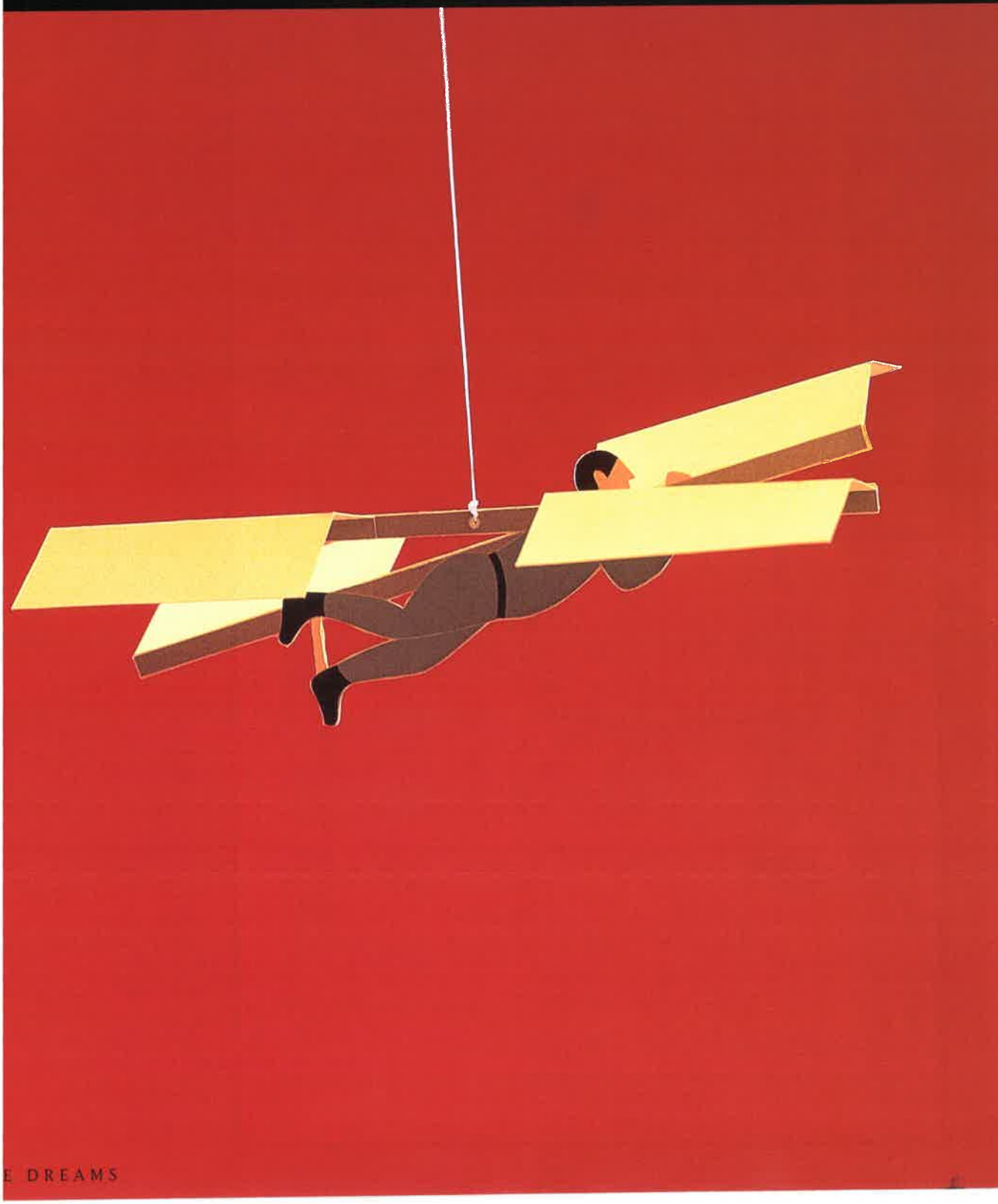
BEZNIER
flapper

non-flying model



E DREAMS

EXPLODED

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

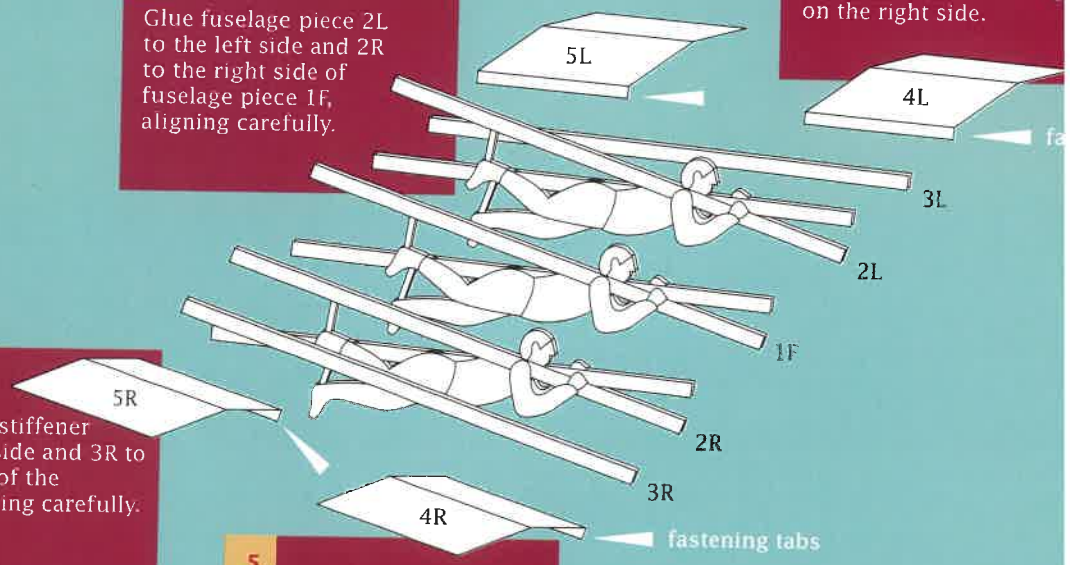
Glue fuselage piece 2L to the left side and 2R to the right side of fuselage piece 1F, aligning carefully.

3

Glue fuselage stiffener 3L to the left side and 3R to the right side of the fuselage, aligning carefully.

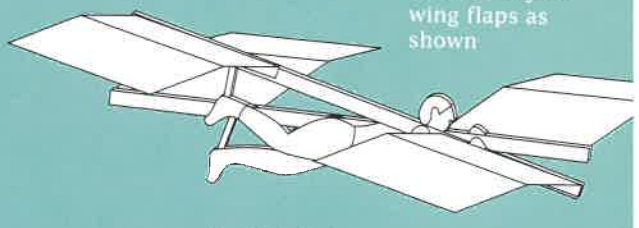
4

Bend fastening tabs on w
flap pieces 4L and 5L,
gluing them to the front
back ends of the fuselag
on the right side.



5

Bend fastening tabs on wing flap pieces 4R and 5R, gluing them to the front and back ends of the fuselage on the right side.



on the finished aircraft, adjust wing flaps as shown

the finished aircraft

PIECES

beznier

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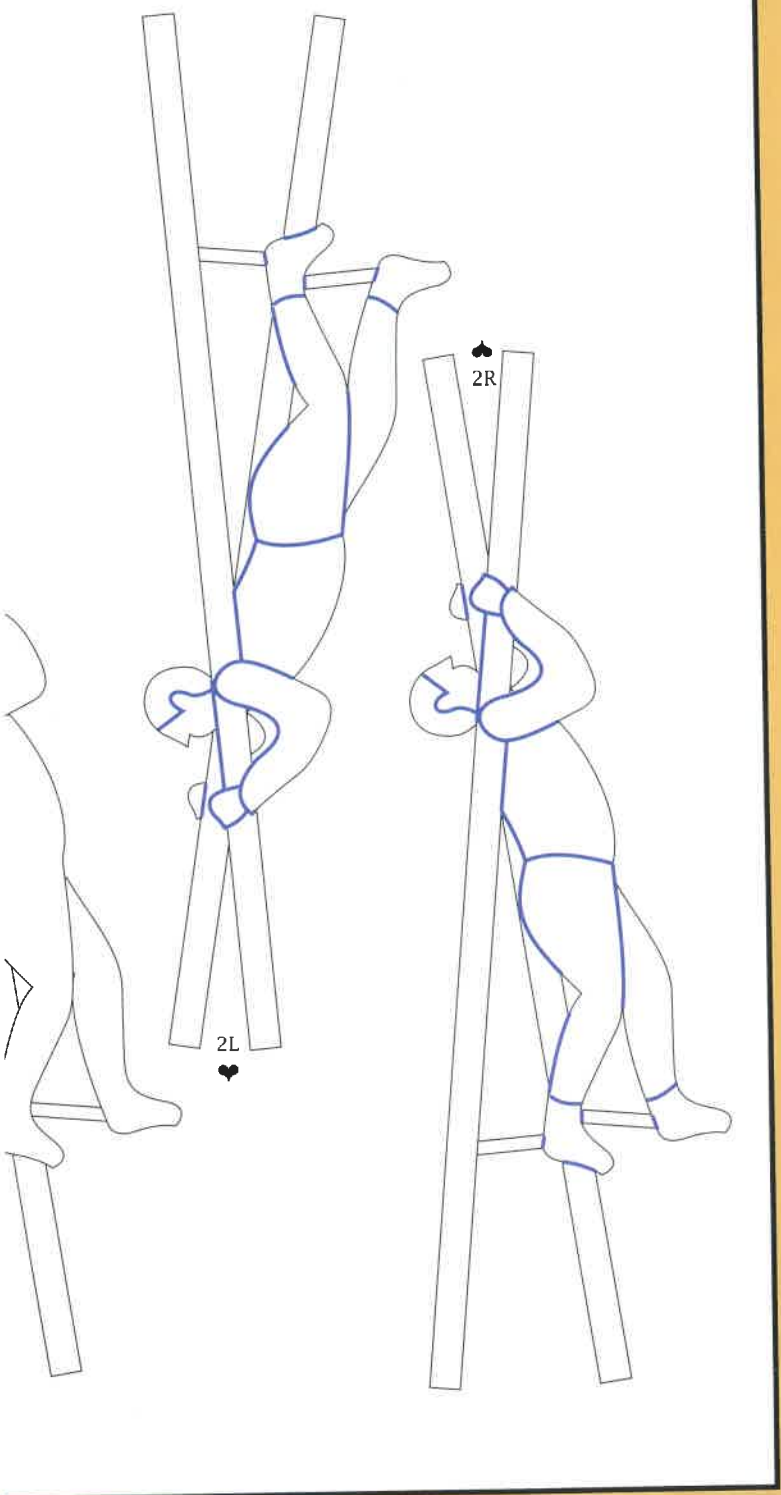
as guides for adding details to the aircraft.
t edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



Incredible as it may seem to us today, for a long time it was thought that simply strapping on some wings, flapping them with arms and legs, while jumping from some high place would result in human flight. There were many of these jumpers and flappers over the centuries. Among them was a French locksmith named Beznier. In 1678 he built a wing-flapping apparatus. His invention differed from most others because he had not only one set of wings, but two. His machine consisted of a pole held over each shoulder with a hinged wing at each end. The poles were attached to his wrists and ankles by ropes. He would then pump his arms and legs up and down. During each upward sweep

BEZNIER PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- ➧ Indicates the front edge of the piece.

NOTE
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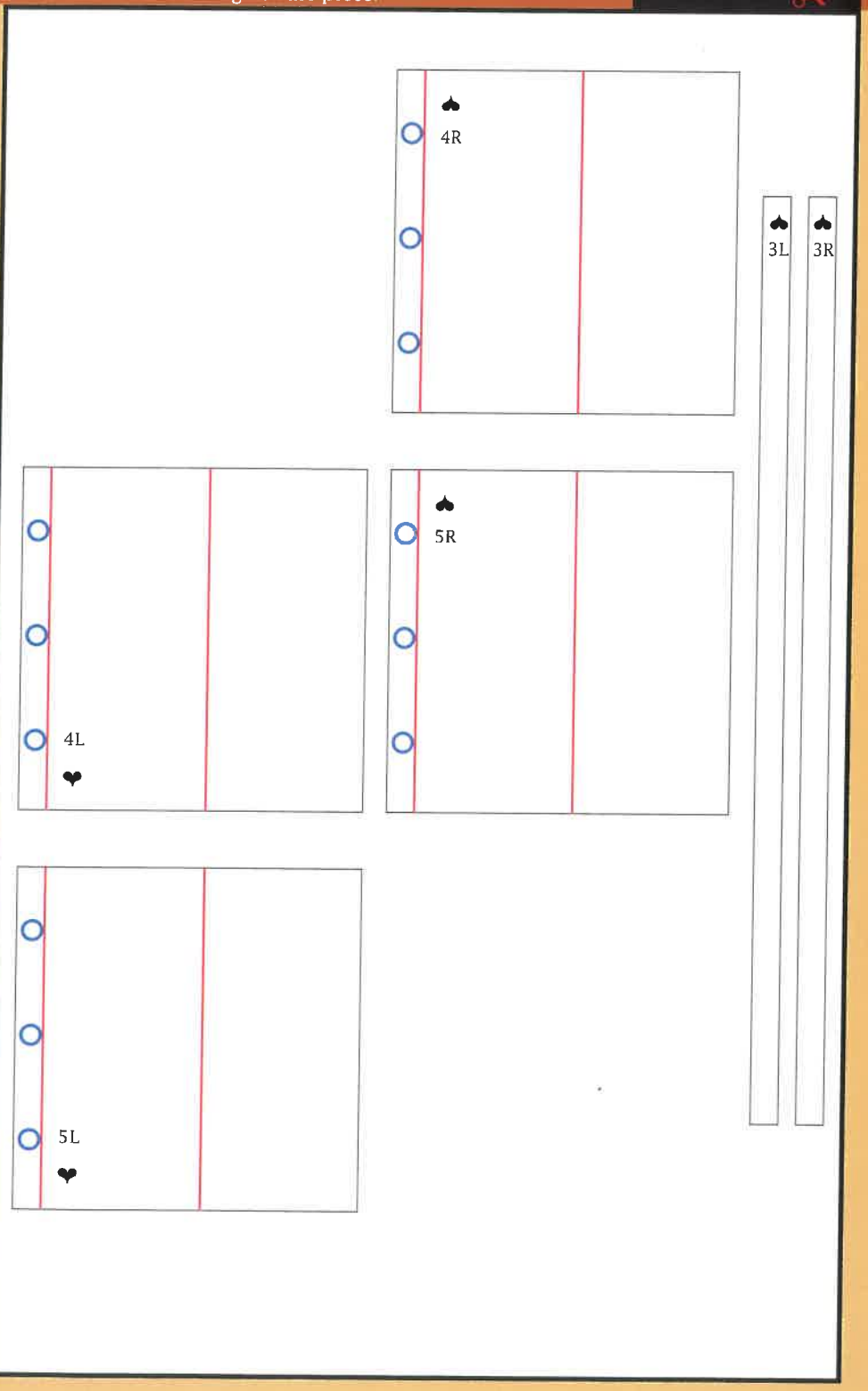

the hinged wings w
closed, and with ea
sweep they would c
one hand wing and
foot wing would alv
while the other two
This alternating up
opening and closing
intended to provide
pulsion. Accounts o
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cate that he could ju
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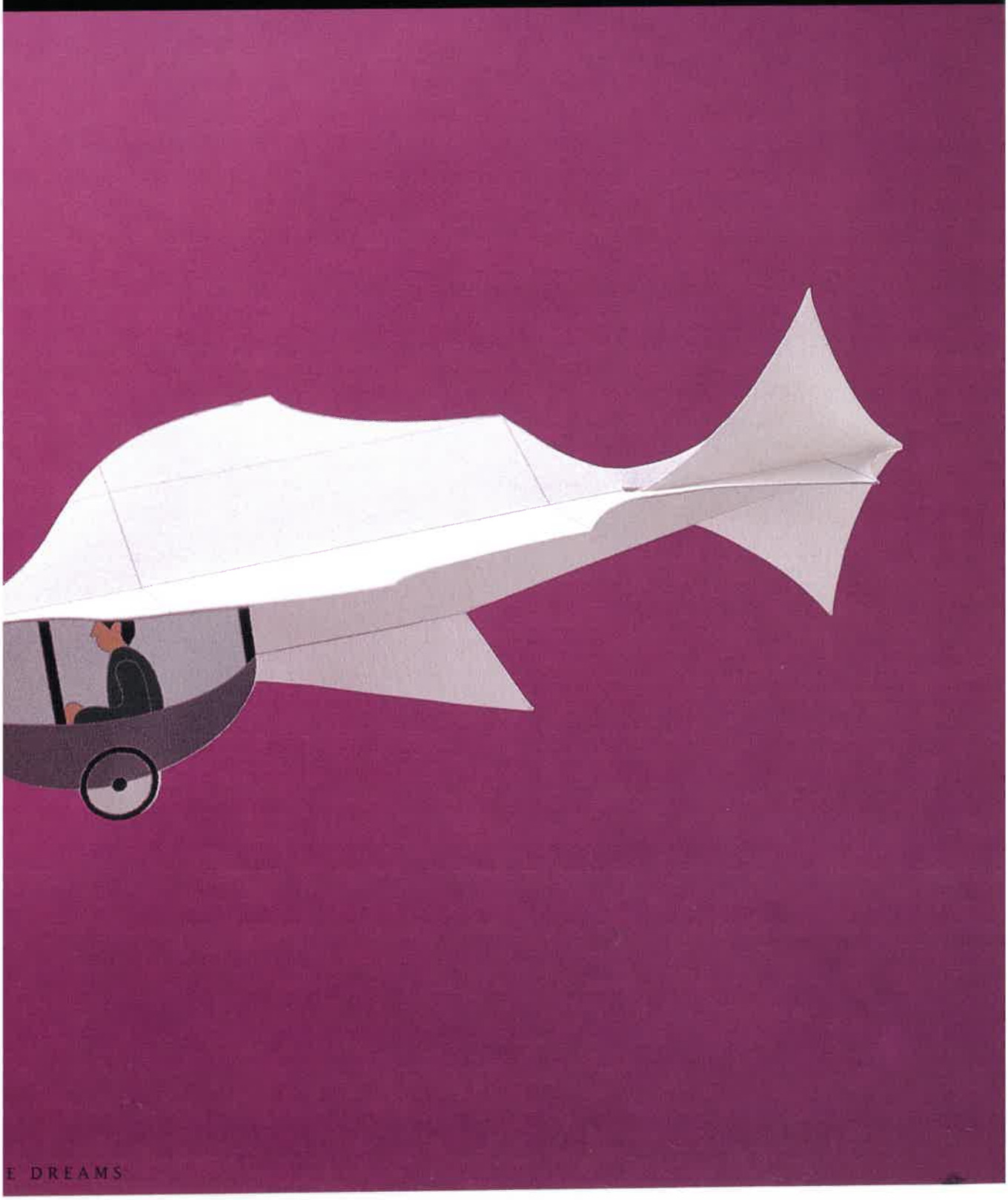
some measure of su

flying model

CAYLEY glider



E DREAMS

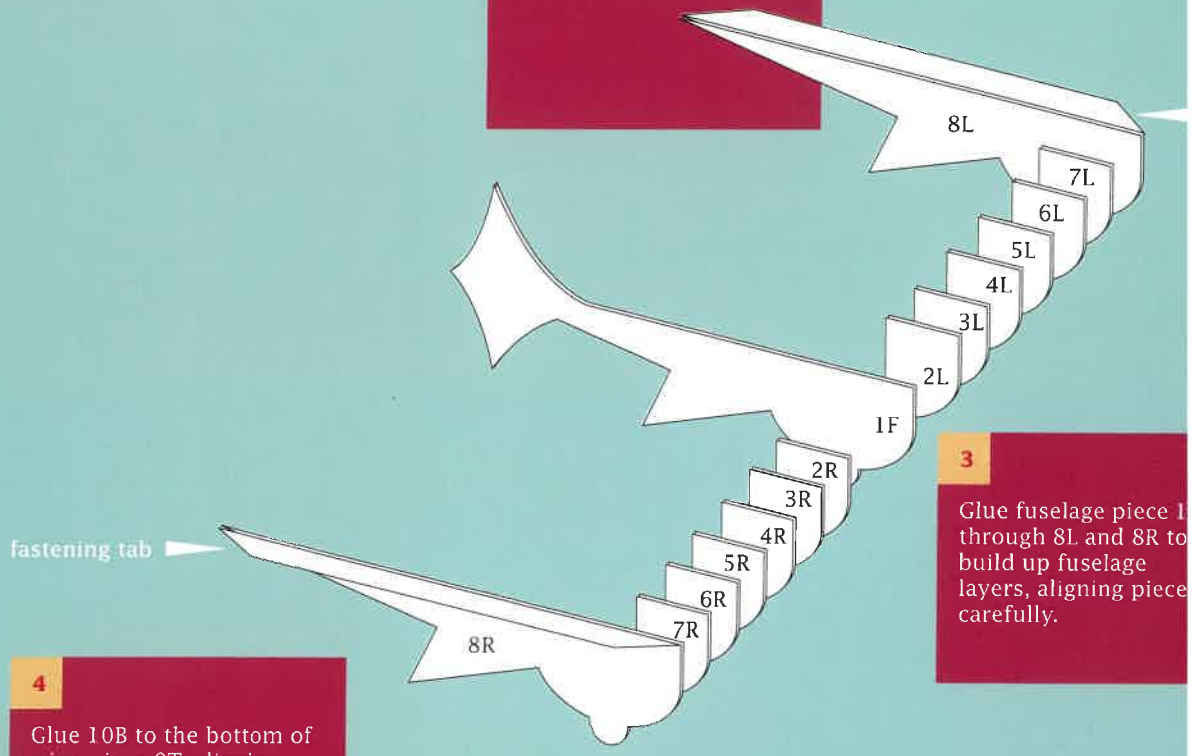
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 8L and 8R.

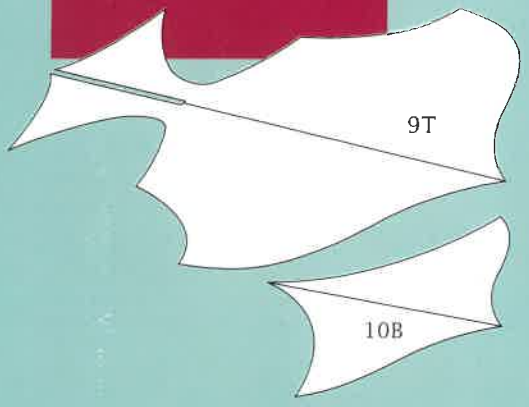


3

Glue fuselage piece 1 through 8L and 8R to build up fuselage layers, aligning piece carefully.

4

Glue 10B to the bottom of wing piece 9T, aligning centers. Set dihedral as shown below.

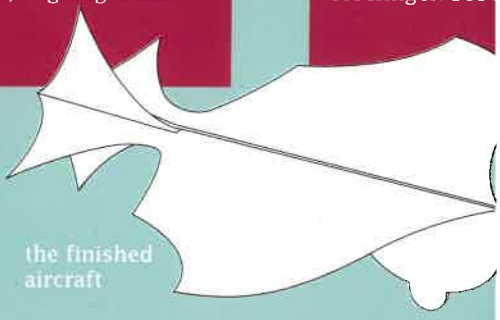


5

Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines.

6

Camber the wi curving the pa between thumb forefinger. See



the finished aircraft

PIECES

cayley

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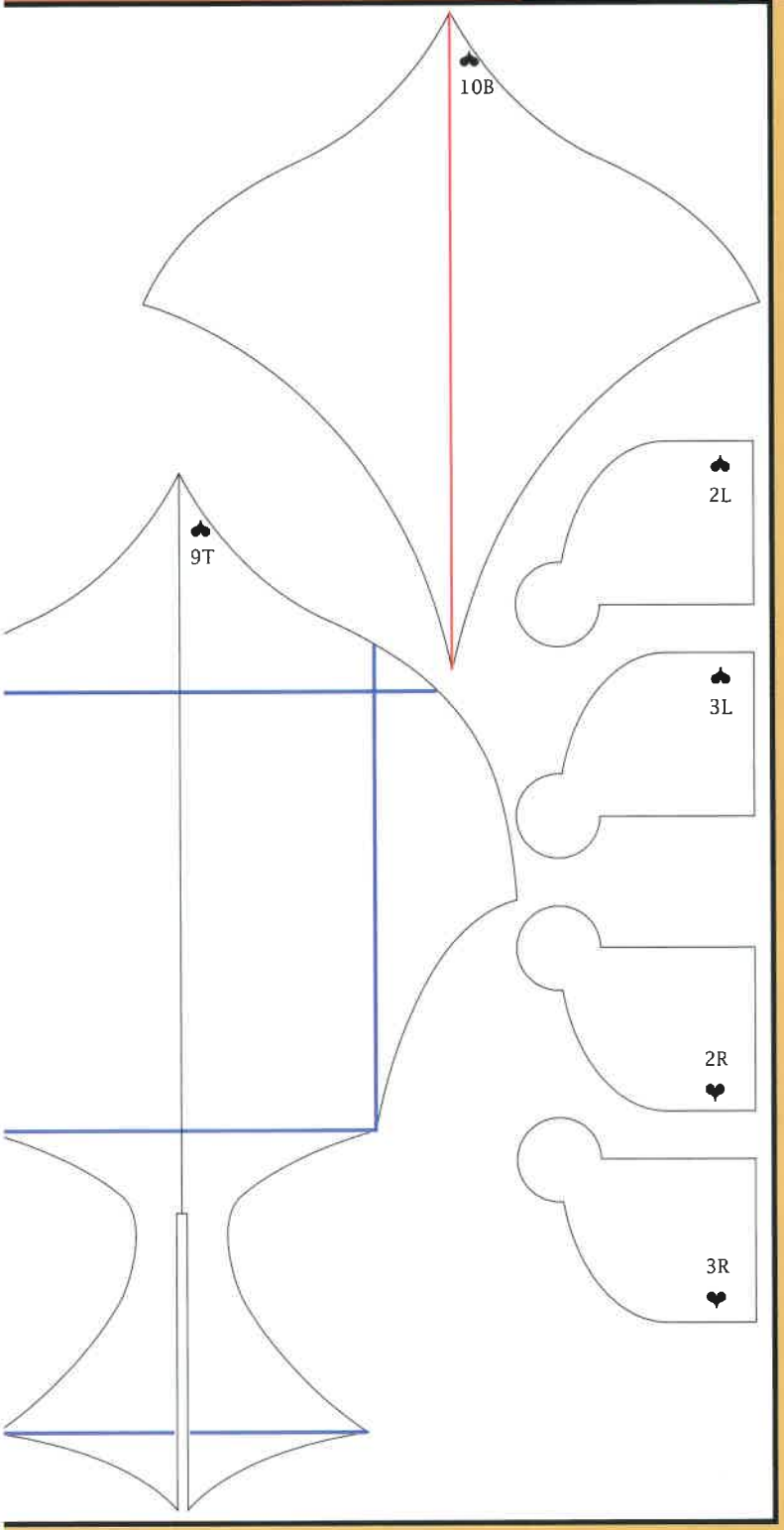
NOTE
CUT OUT PHOTOCOPY ONLY



Sir George Cayley was an English aristocrat, who, while still in his twenties, demonstrated a model helicopter built of feathers and bottle corks and a small glider based on kite designs. He worked out mathematical formulae for lift and drag factors and understood the importance of a curved wing surface to create a pressure differential over and under the wing to generate a lifting force. His model glider, built in 1804, already had in place all the correct shapes of the major parts that one might find on airplanes today.

In Cayley's day inventors were experimenting with various kinds of engines for generating power and the most important were steam engines. But these engines were too big and heavy and had only small power output. Cayley realized that they were unsuitable for use in airplanes. Therefore he spent no time on powered flight, concentrating instead on solving the problems of lift and drag in gliding flight.

CAYLEY PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
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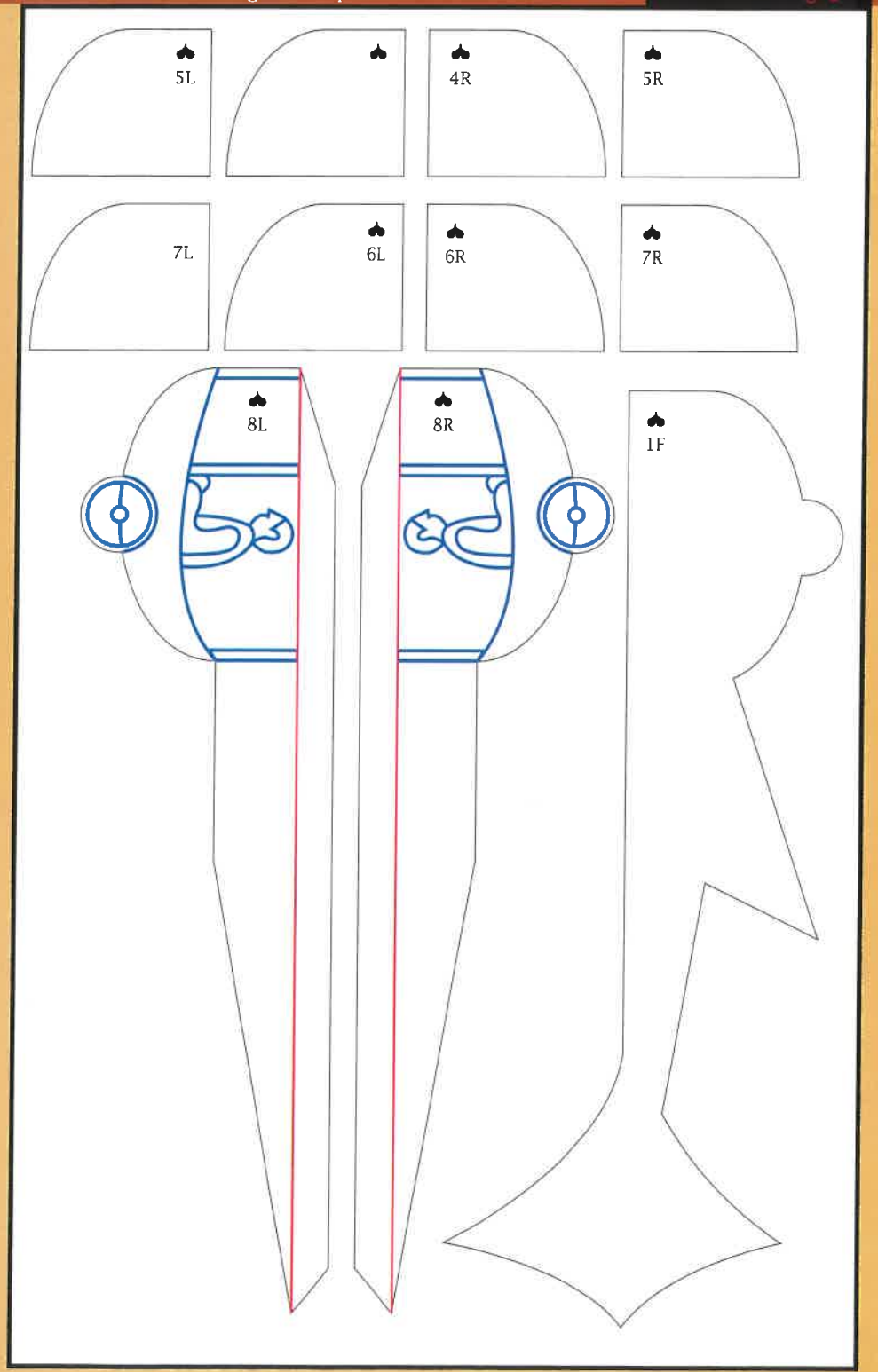


In the 1840s he was v
various designs of ful
These were kite-like i
boat-like fuselages slu
neath. Cayley still had
out a means of turnin
confidence from man
unmanned gliding flig
in 1853 persuaded his
to climb on board and
high point in a straigh
glide. This has been s
history as the first ob
recorded free-flight of
being in a heavier-tha
chine. It earned Cayle
Father of Aviation. Th
on the other hand, wa
and upon landing han
notice, declaring that
hired to drive not fly.

HENSON
ariel

non-flying model

LE DREAMS

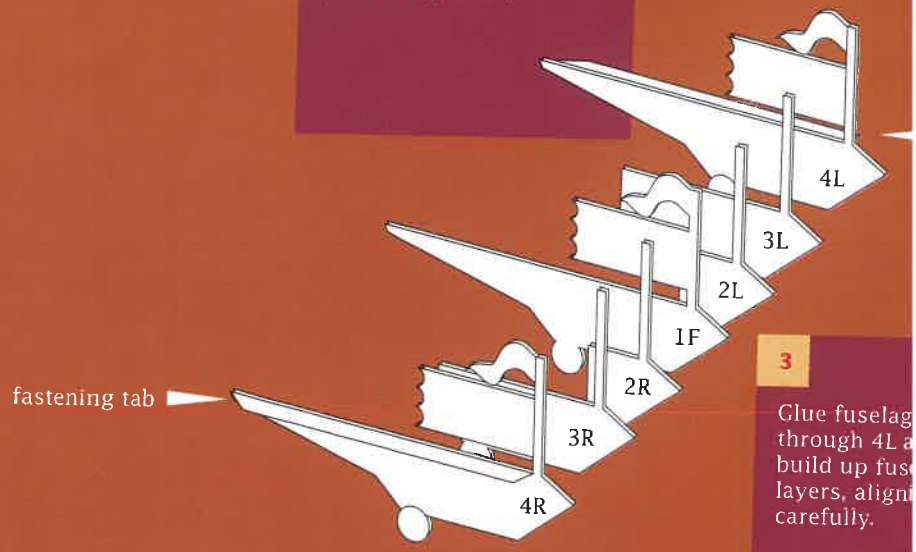
EXPLODED

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 4L and 4R.



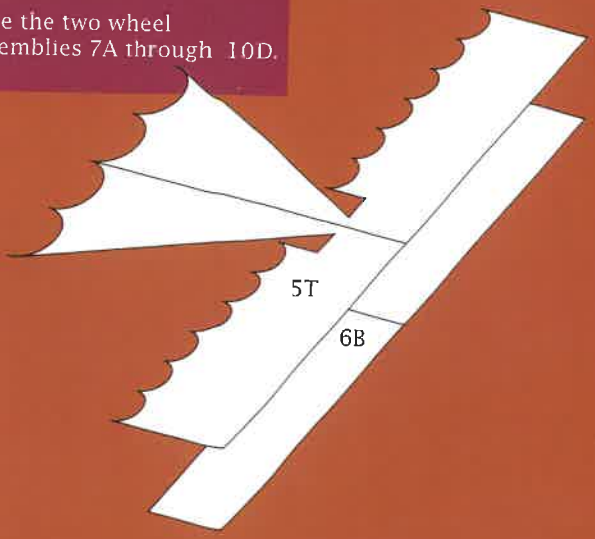
3

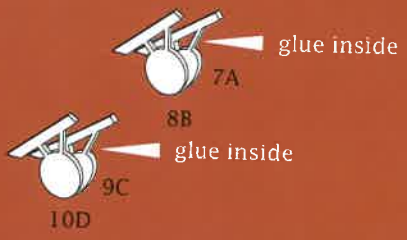
Glue fuselag
through 4L a
build up fus
layers, align
carefully.

4

Glue 6B to the bottom of wing piece 5T, aligning centers. No dihedral.

Glue the two wheel assemblies 7A through 10D.





5

Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines. No camber.

6

Glue one w
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PIECES

henson

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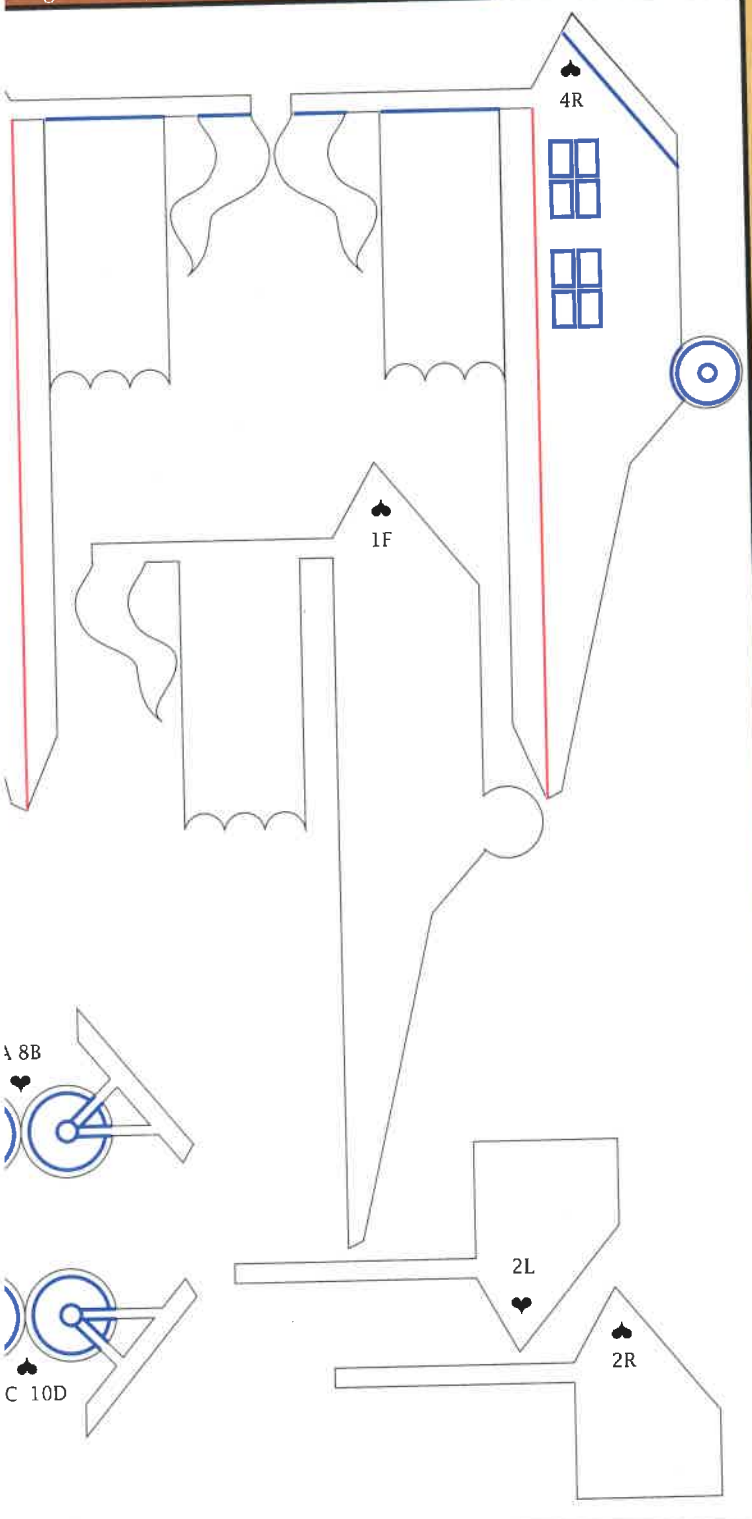
as guides for adding details to the aircraft.
edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



The 19th century was the age of steam power. Steam drove industrial plants, farm machinery, and trains.

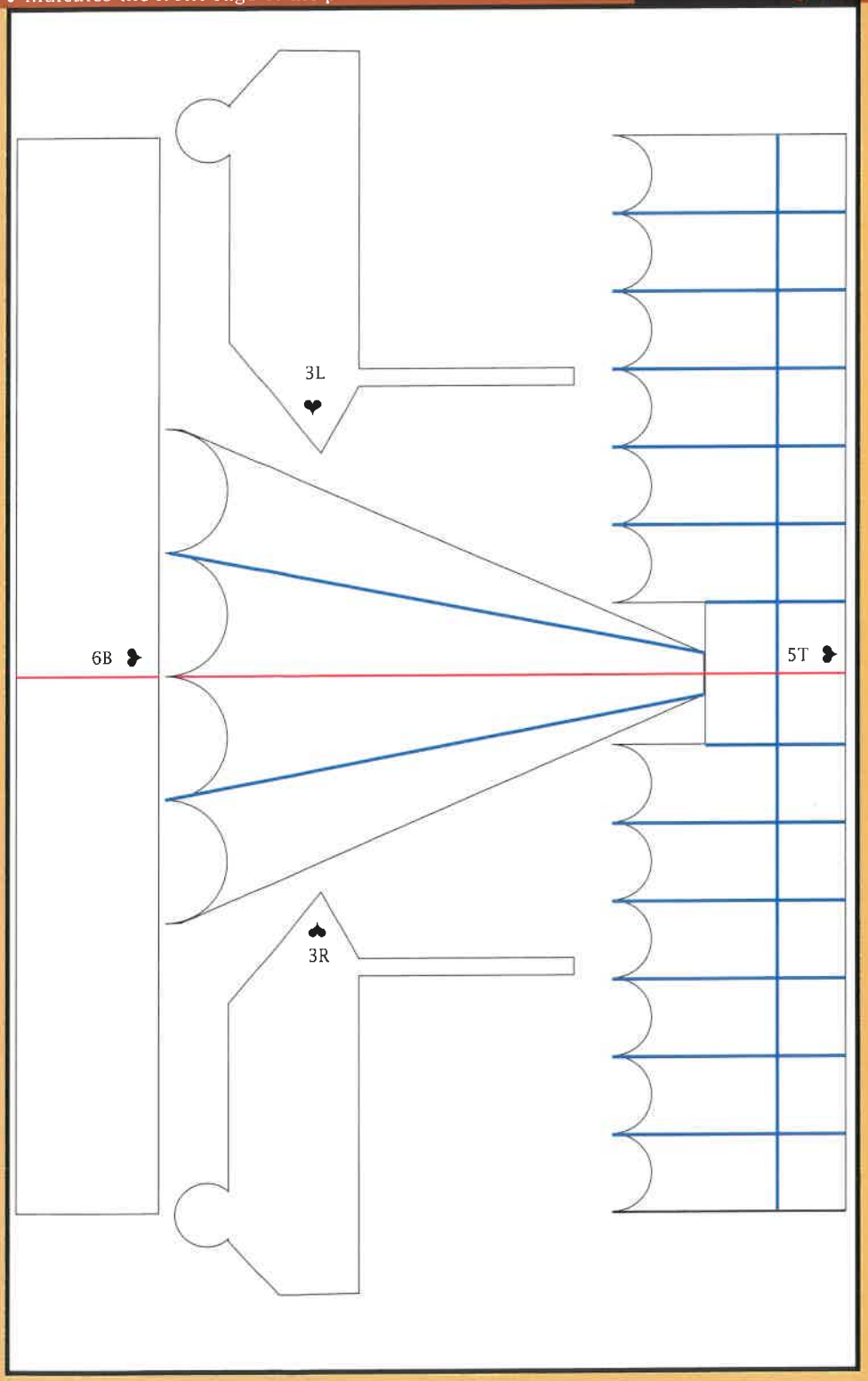
William Samuel Henson was a British civil engineer who had followed Cayley's experiments with keen interest. Unlike Cayley, his dream was to build a steam driven airplane, which he called the Ariel Steam Carriage. It was an incredible yet ingenious flying machine. Its design proposed a wingspan of 150 feet (46m) and weight (empty) up to 3000 lb (1400kg). This monoplane had an enclosed fuselage for engine, crew, passengers, and freight, with the entire structure covered in oiled silk.

Henson's design generated a great deal of public interest. In 1843 it even led to the Ariel Transit Bill being introduced in the Britsh

HENSON PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- ➧ Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



parliament, calling f
to operate Ariels aro
Worldwide publicity
Ariels steaming maj
atop the masts, high
country – even inclu
pyramids of Egypt. A
ings were also plann
souvenirs were avail
ful supply.

But Henson's dream,
though it was, far ex
bility. His 30 hp stea
could never have dr
chine forward with e
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the air. When even a
weight model of the
lift off the ground, p
construction were al
Thereafter Henson l
turning his attentior
interests.

PHILLIPS

multiplane

non-flying model

E DREAMS

EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 3L and 3R.

3

Glue fuselage through 3L and build up fusela layers, alignin carefully.

4

Glue the two wheel assemblies 4A through 7D.

5

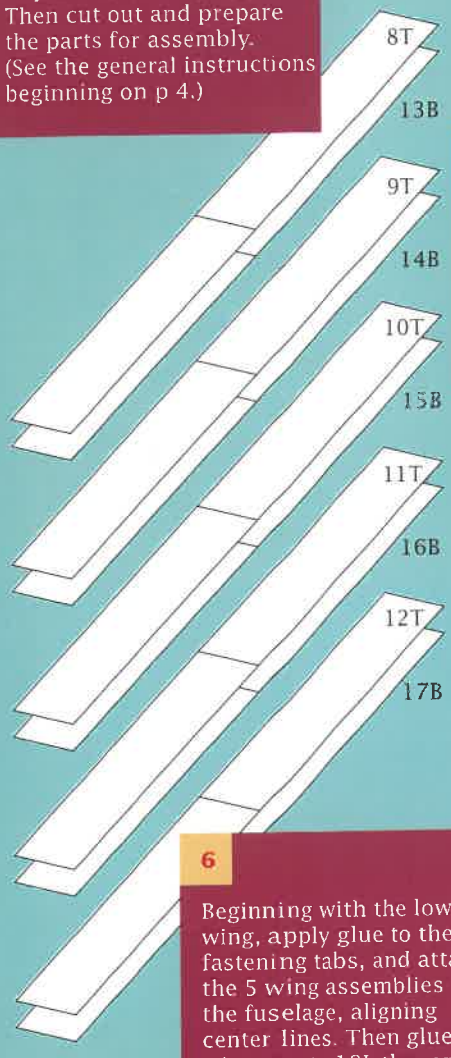
Glue 13B through 17B to the bottom of wing pieces 8T through 12T, aligning centers. No dihedral.

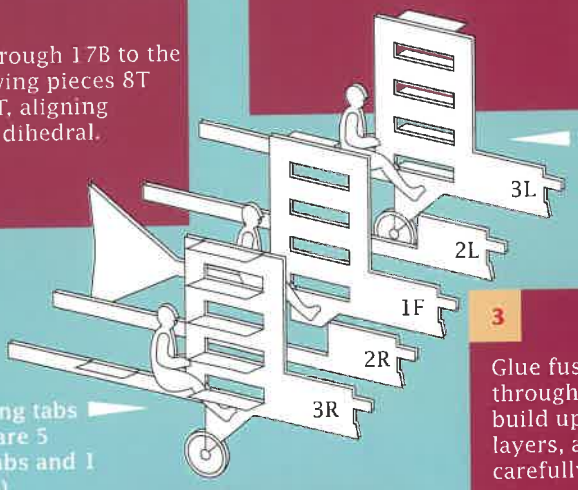
6

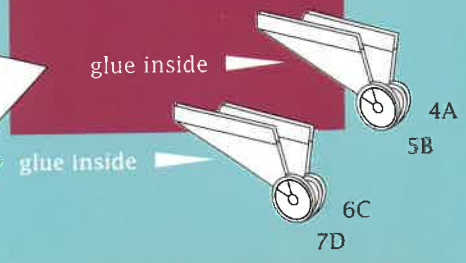
Beginning with the lowest wing, apply glue to the fastening tabs, and attach the 5 wing assemblies to the fuselage, aligning center lines. Then glue wing struts 18L through 25R in place on each side, as shown.

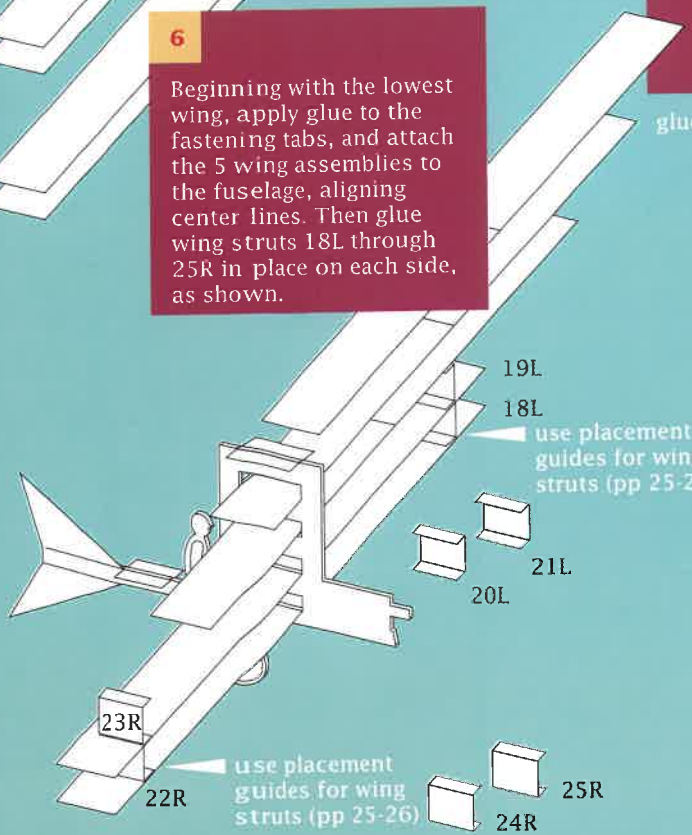
7

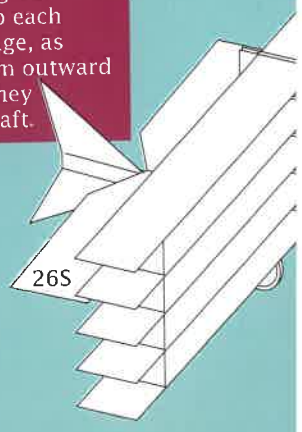
Applying glue to the tail tabs, attach the stabilizer 26S to the fuselage. Then glue one wheel to each side of the fuselage, as shown. Bend them outward slightly so that they support the aircraft.











PIECES

phillips

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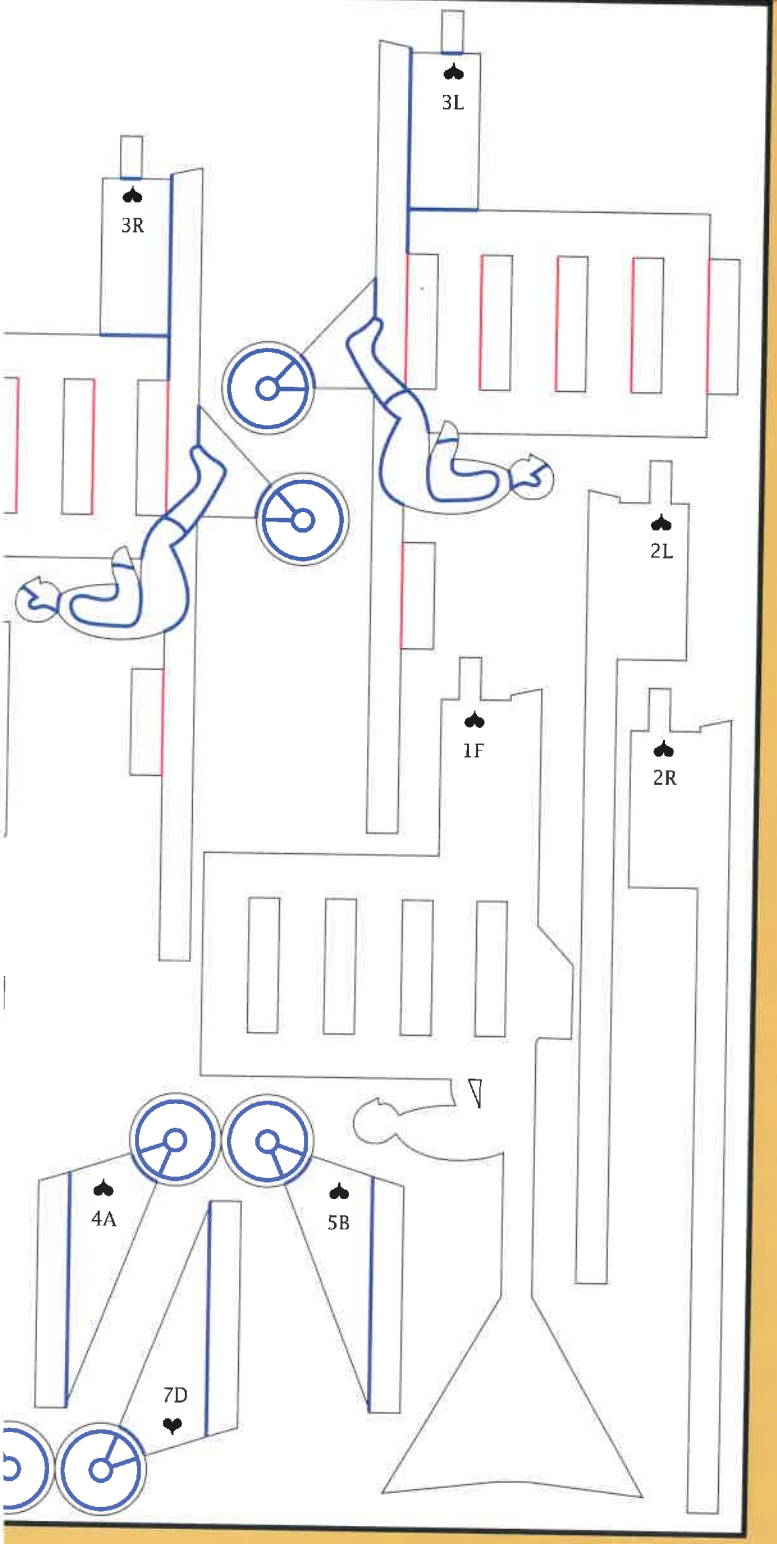
es as guides for adding details to the aircraft.
ont edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



When it became commonly known that the curvature of a wing's upper surface was the key to generating a lifting force, various individuals interpreted its application differently.

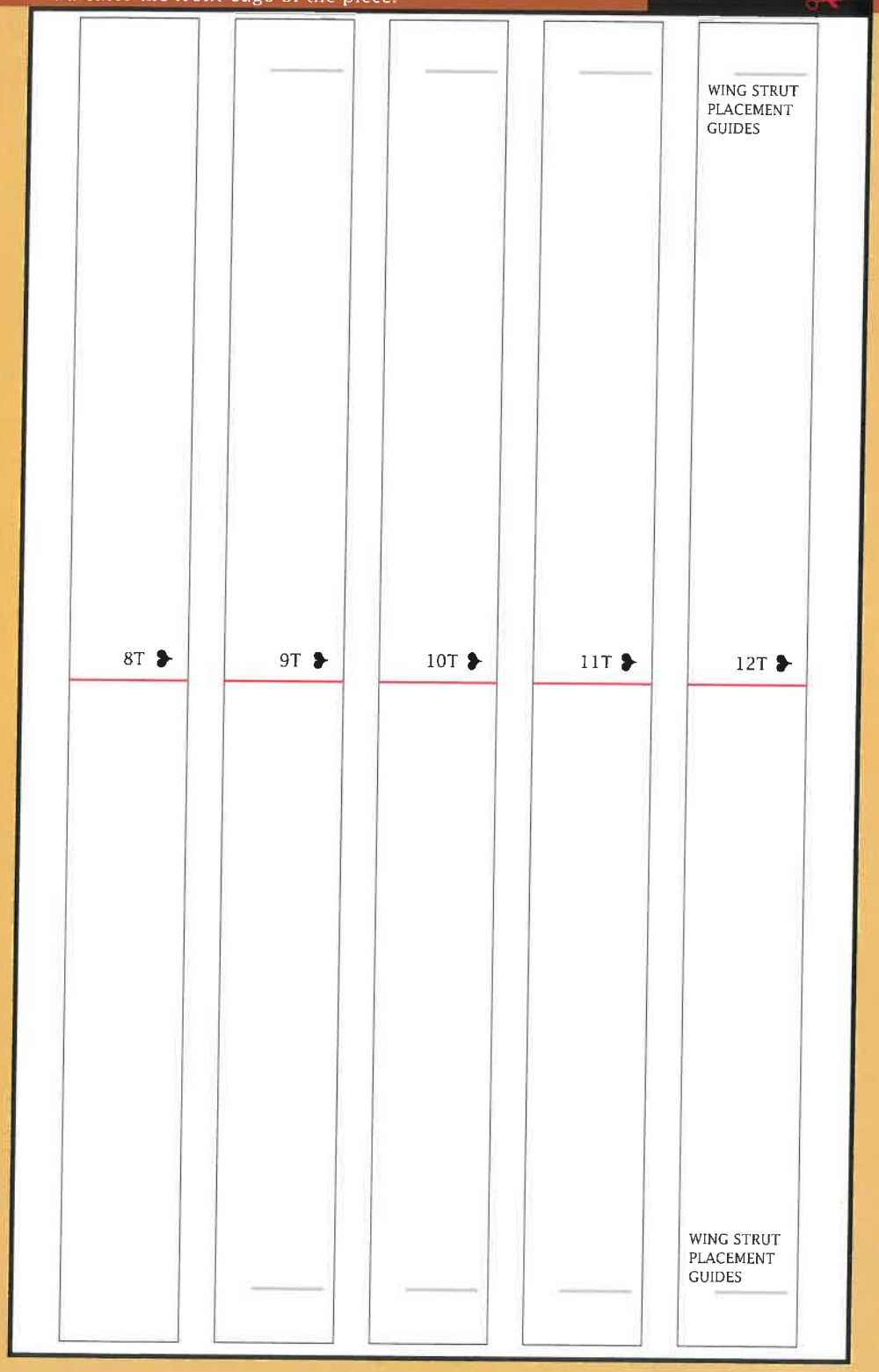
Englishman Horatio Phillips experimented with wings of different aspect ratios (proportions of width to length) and discovered that long narrow wings were more efficient in generating lift.

Beginning in 1893 and for many years thereafter, he designed a number of incredible multiplanes. He believed that successful flight could be achieved by stacking many long and narrow wings (high aspect ratio). One of his airplanes had no fewer than 160 such wings, making it look much like a flying venetian blind.

PHILLIPS PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- ➧ Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



Such complex struc
incredibly difficult
resulting in many fa
flight trials. For safe
of these were unma
success resulted fro
flights. The multipl
flight – unmanned i
only about 500 feet

Phillips is best reme
work in experimenti
wing surfaces and th
the work of others i
modern high aspect
early in the 20th cen
gliders have very eff
and long wings allov
travel great distance
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ES

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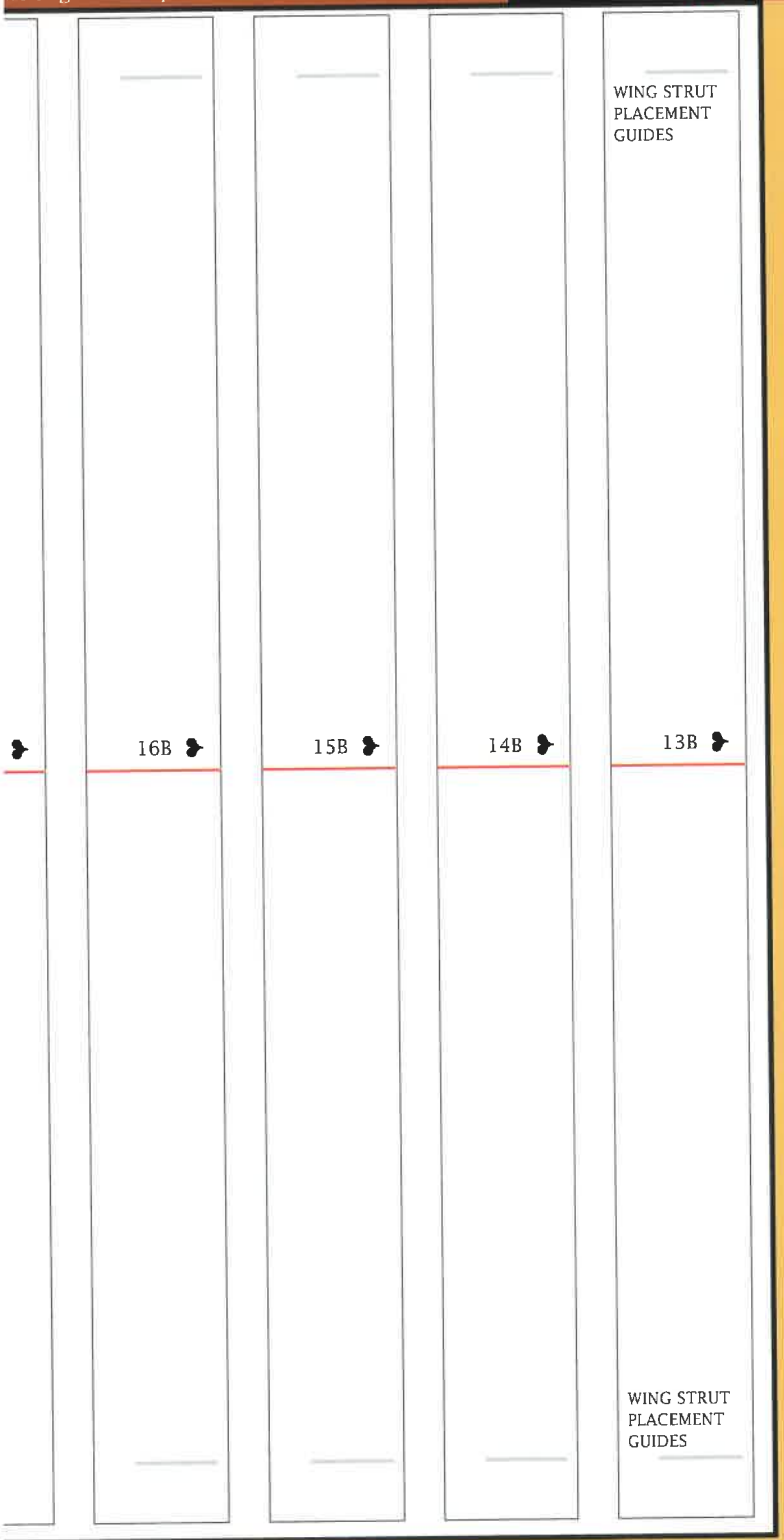
NOTE
CUT OUT PHOTOCOPY ONLY



LANGLEY

tandem wings

EXPLODED VIEW

yout pages
model.
prepare
embly.
instructions
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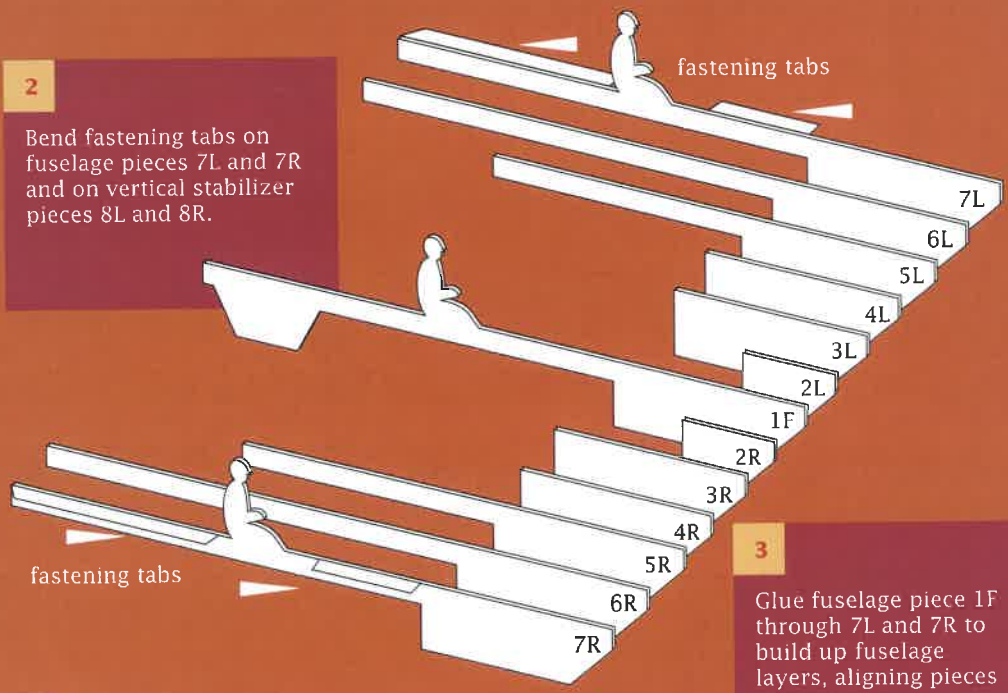
2

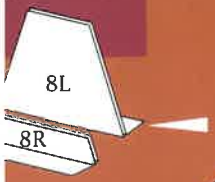
Bend fastening tabs on fuselage pieces 7L and 7R and on vertical stabilizer pieces 8L and 8R.



rtical
plying glue
ing it to 8L.
ssembly to
the center

3

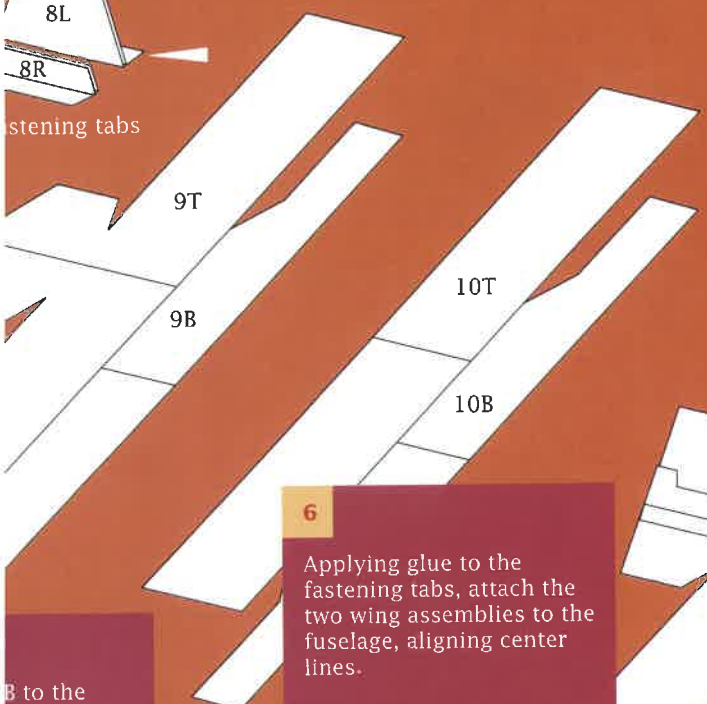
Glue fuselage piece 1F through 7L and 7R to build up fuselage layers, aligning pieces carefully.



stening tabs

7

Camber the wings by curving the paper gently between thumb and forefinger. See below.



6

Applying glue to the fastening tabs, attach the two wing assemblies to the fuselage, aligning center lines.

B to the
g pieces 9T
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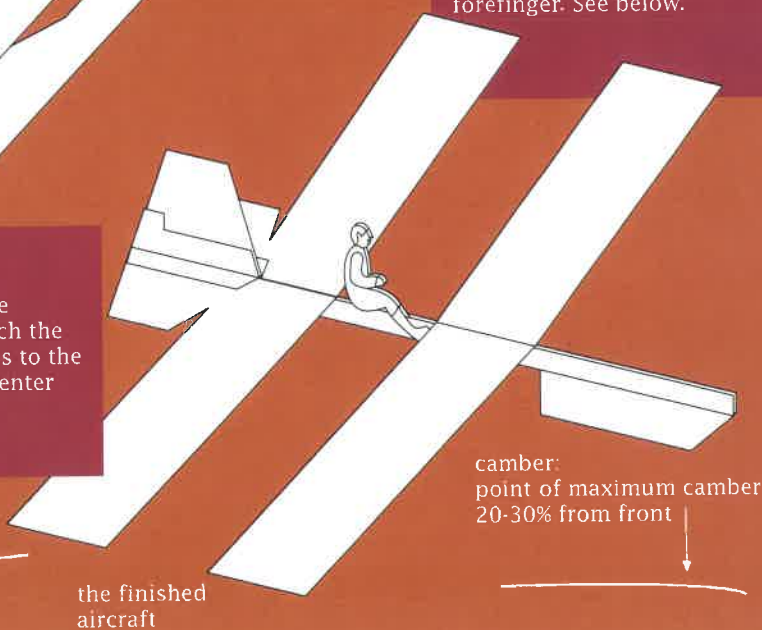
s. Set
th as shown

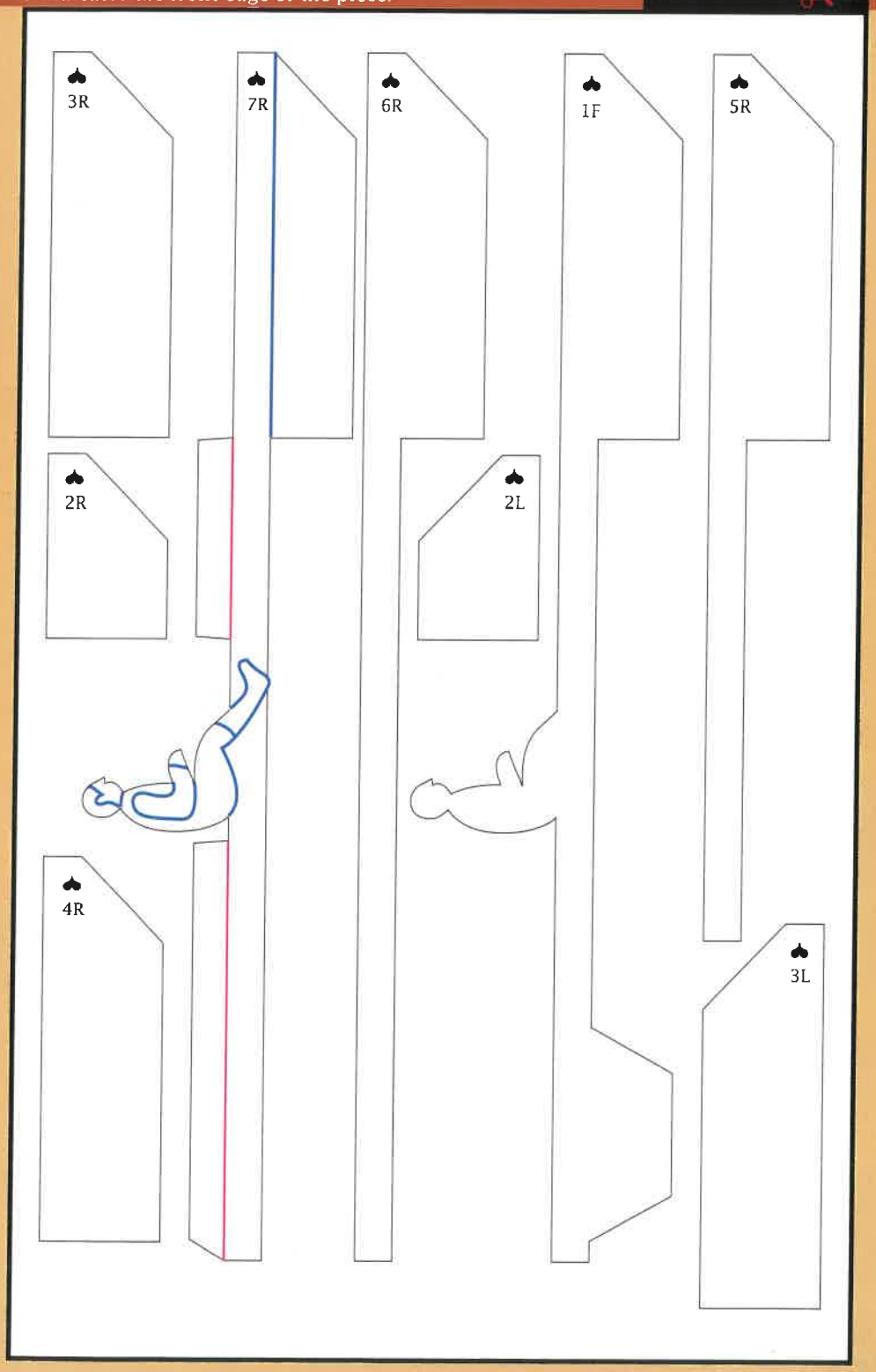


THE PIECES

langle

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- ♠ Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



The work of Samuel Pierpont La of the Smithsonian overshadowed by t success and publici brothers. Conseque accomplishments a known. However he incredible achieve unmanned flight an the Wrights in the fi and powered flight some unfortunate m wrong time.

In 1891 Langley beg small-scale airplane of his early experim small steam engines

ES

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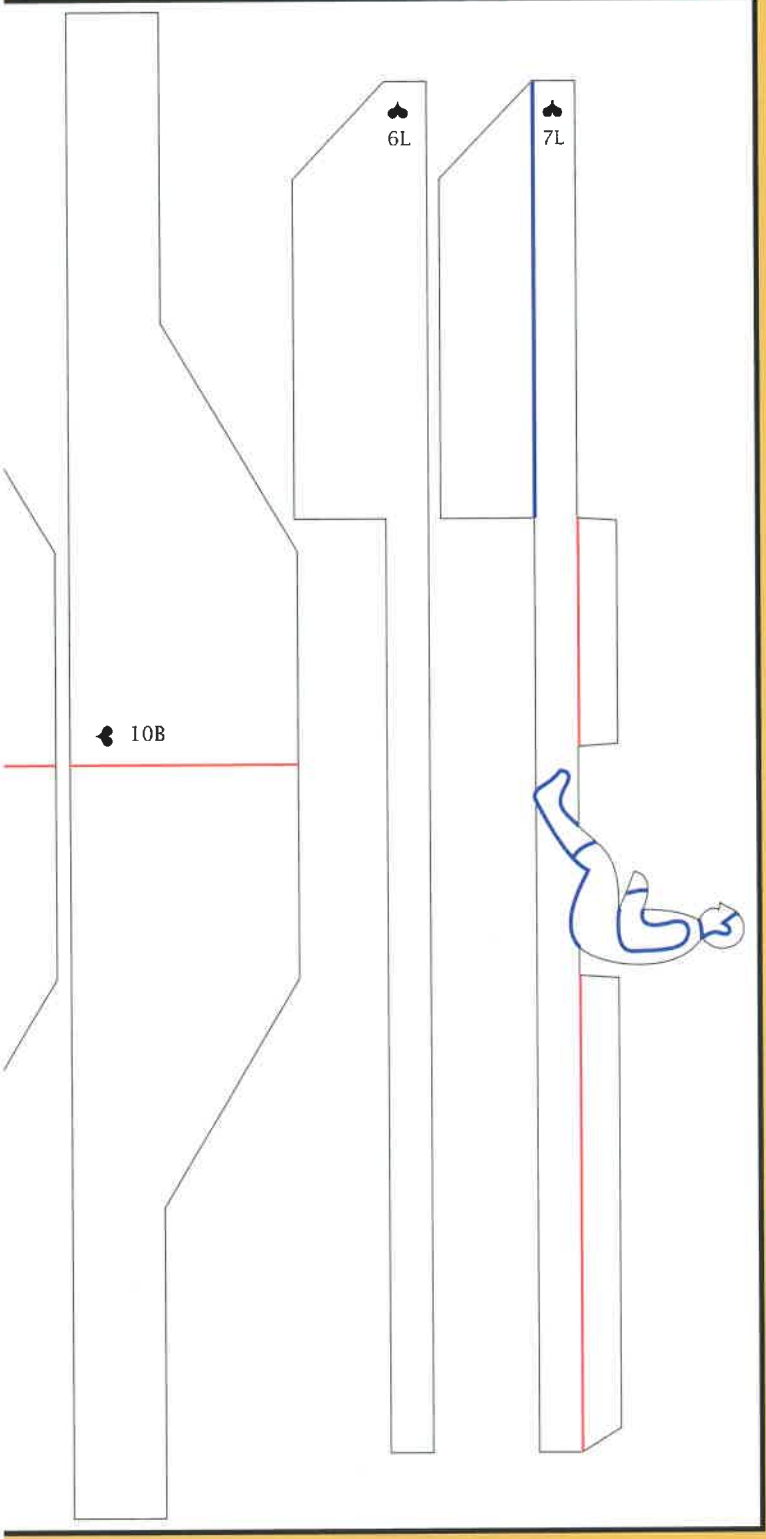
s as guides for adding details to the aircraft.
ht edge of the piece.

NOTE:
CUT OUT PHOTOCOPY ONLY

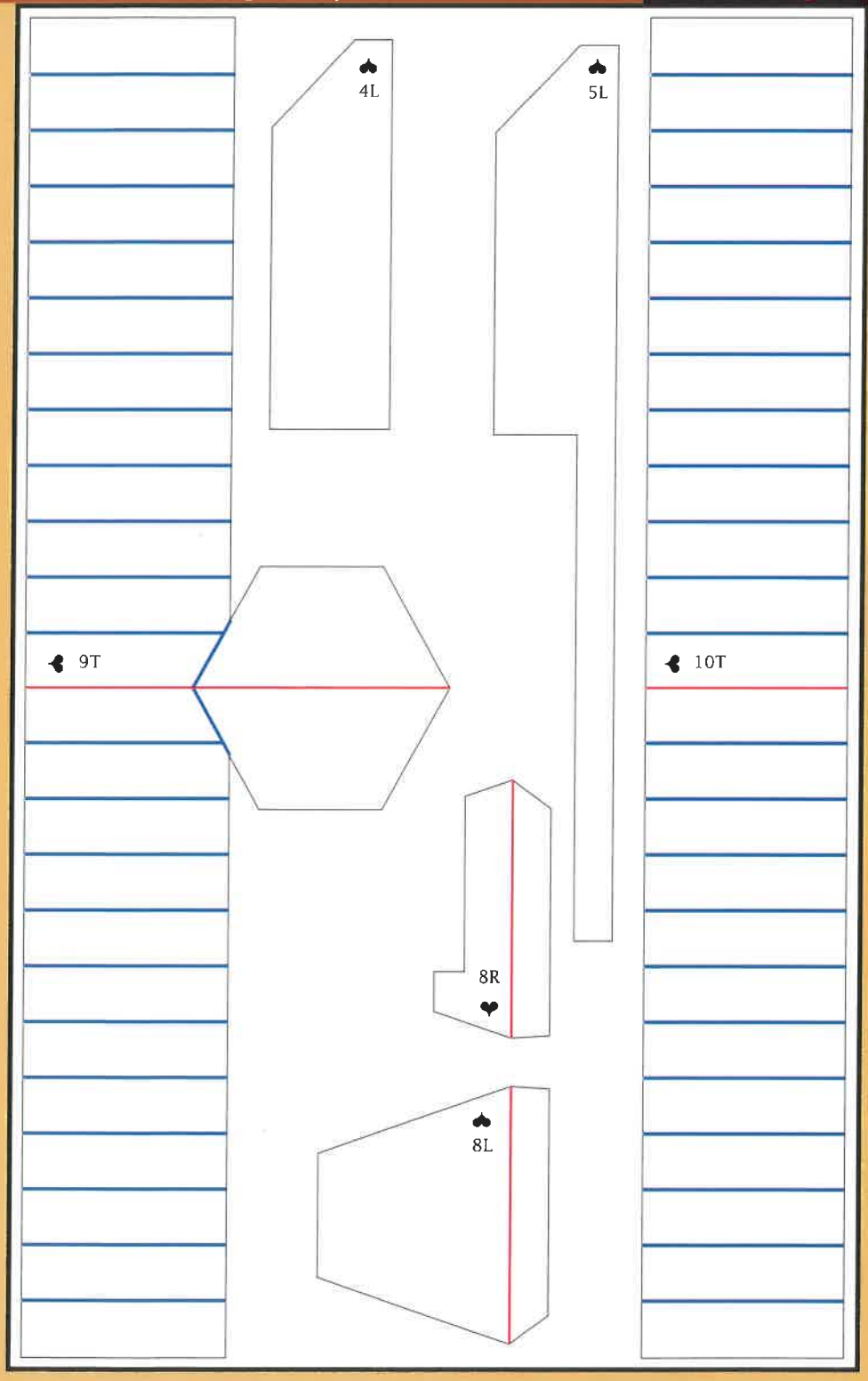


sion. He encountered the same difficulties that all other would-be aviators faced as they attempted to build a frame sufficiently light in weight yet strong enough to withstand the forces of launching and flight. Wing distortion was a major problem. Langley's planes were a tandem wing design – two similar wings mounted one in front of the other, called aerodromes. In 1895, his 14 foot (4m) model airplane managed two flights and utilized a small 1 hp steam engine. Incredibly, the longest flight was over 4000 feet (1200m). Langley was satisfied with these results yet he knew that no steam engine could be built that was light enough with sufficient power to propel a full-

LANGLEY PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



sized airplane. The in
bustion engine had ju
invented, and Langley
hp gasoline-burning r
for his larger planes.

An unmanned three-q
model flew well in 19
year that the Wrights
successful first flight.
nately for Langley, in
his full-size plane cau
launcher and failed to
Disappointed, his fina
withdrew their suppo
experimentation. In 1
after Langley's death,
merits of the design,
airodrome was rebuil
successfully.

TAYLOR
aerocar
(will fly with wheels removed)
LE DREAMS

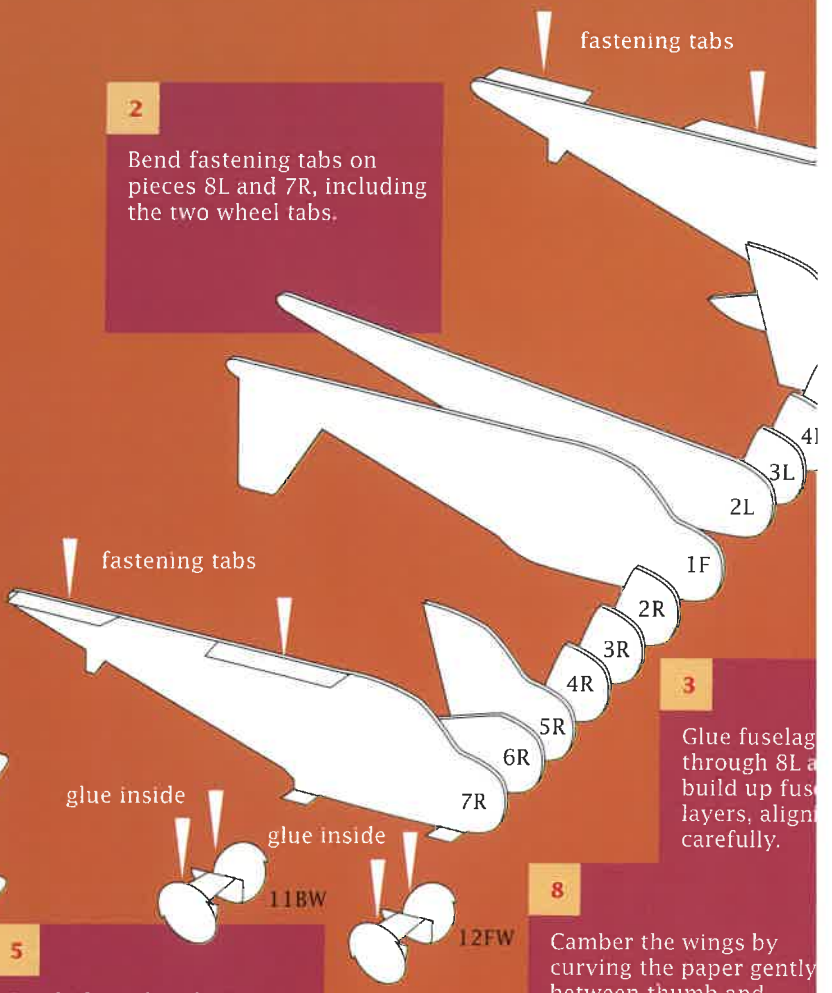
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

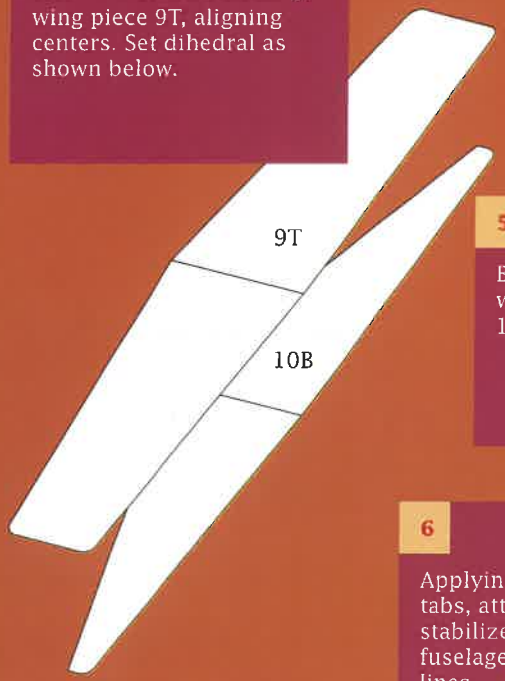
2

Bend fastening tabs on pieces 8L and 7R, including the two wheel tabs.



4

Glue 10B to the bottom of wing piece 9T, aligning centers. Set dihedral as shown below.



3

Glue fuselag through 8L a build up fus layers, align carefully.

5

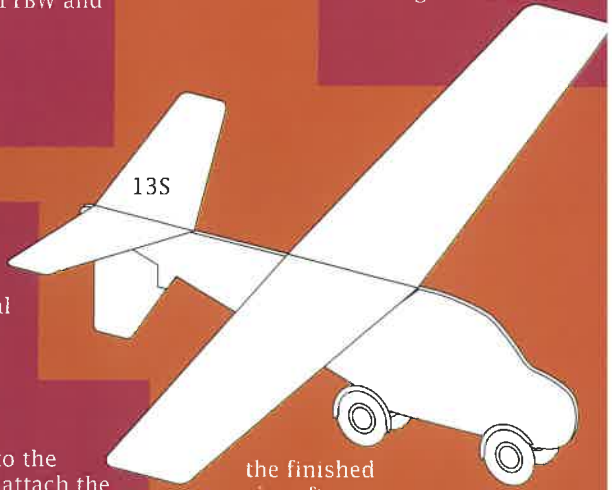
Bend, then glue the two wheel assemblies 11BW and 12FW, as shown.

8

Camber the wings by curving the paper gently between thumb and forefinger. See below.

6

Applying glue to the tail tabs, attach the horizontal stabilizer 13S to the fuselage, aligning center lines.



7

Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines. Then glue wheel assembly 11BW to the back and 12FW to the front, as shown right.

the finished aircraft

camber:
point of maximu
20-30% from fro

dihedral angle:
wings 3°
hor stab 30°

PIECES

taylor

hown in black.
red.
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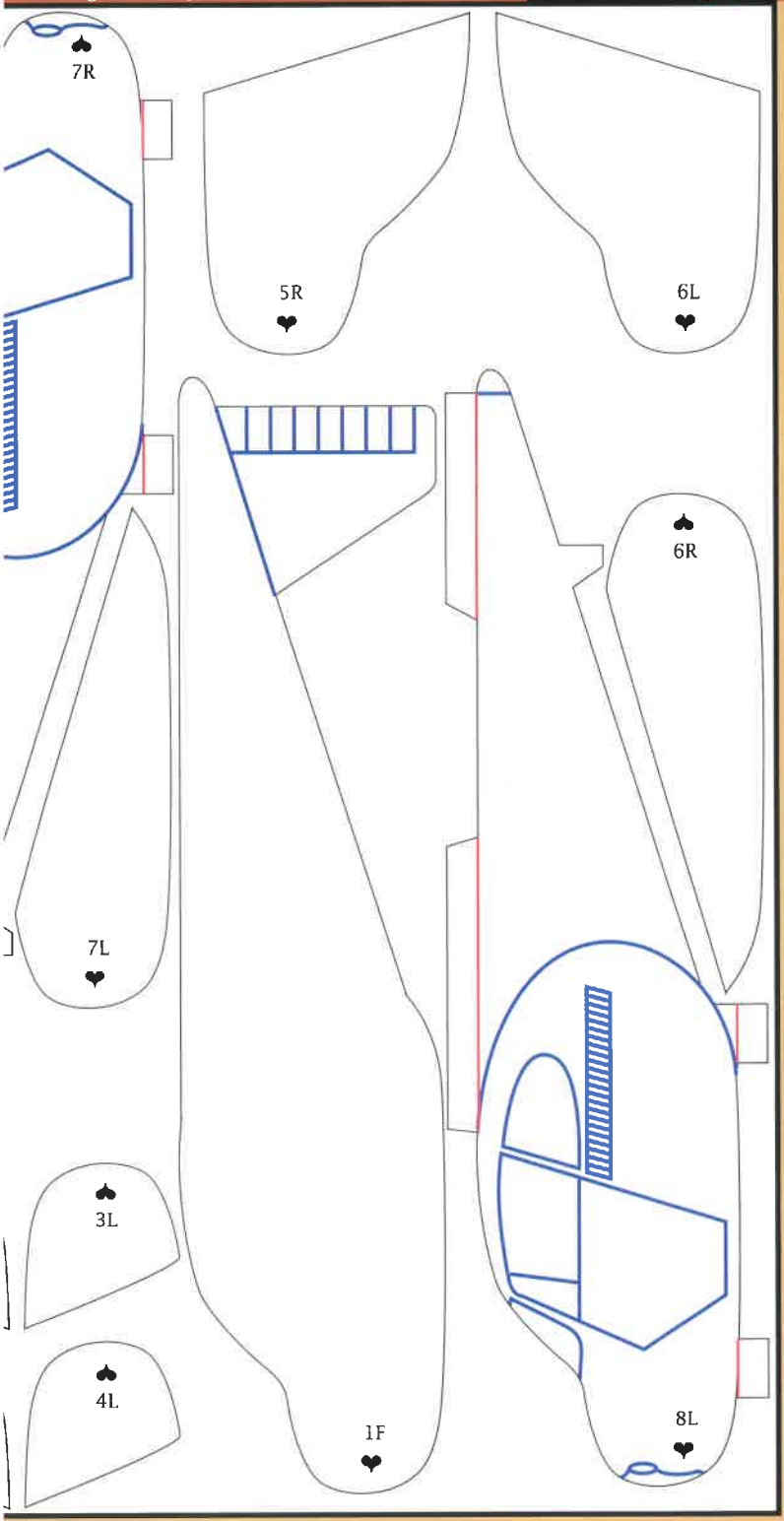
NOTE
CUT OUT PHOTOCOPY ONLY



Moulton Taylor was an innovator. During the Second World War he worked for the United States Navy as an aeronautical engineer. He was interested in remotely controlled aircraft, and he was the first to show that an unmanned weapon could change its course after launch. The work he began at that time later became the Tomahawk Missile Program.

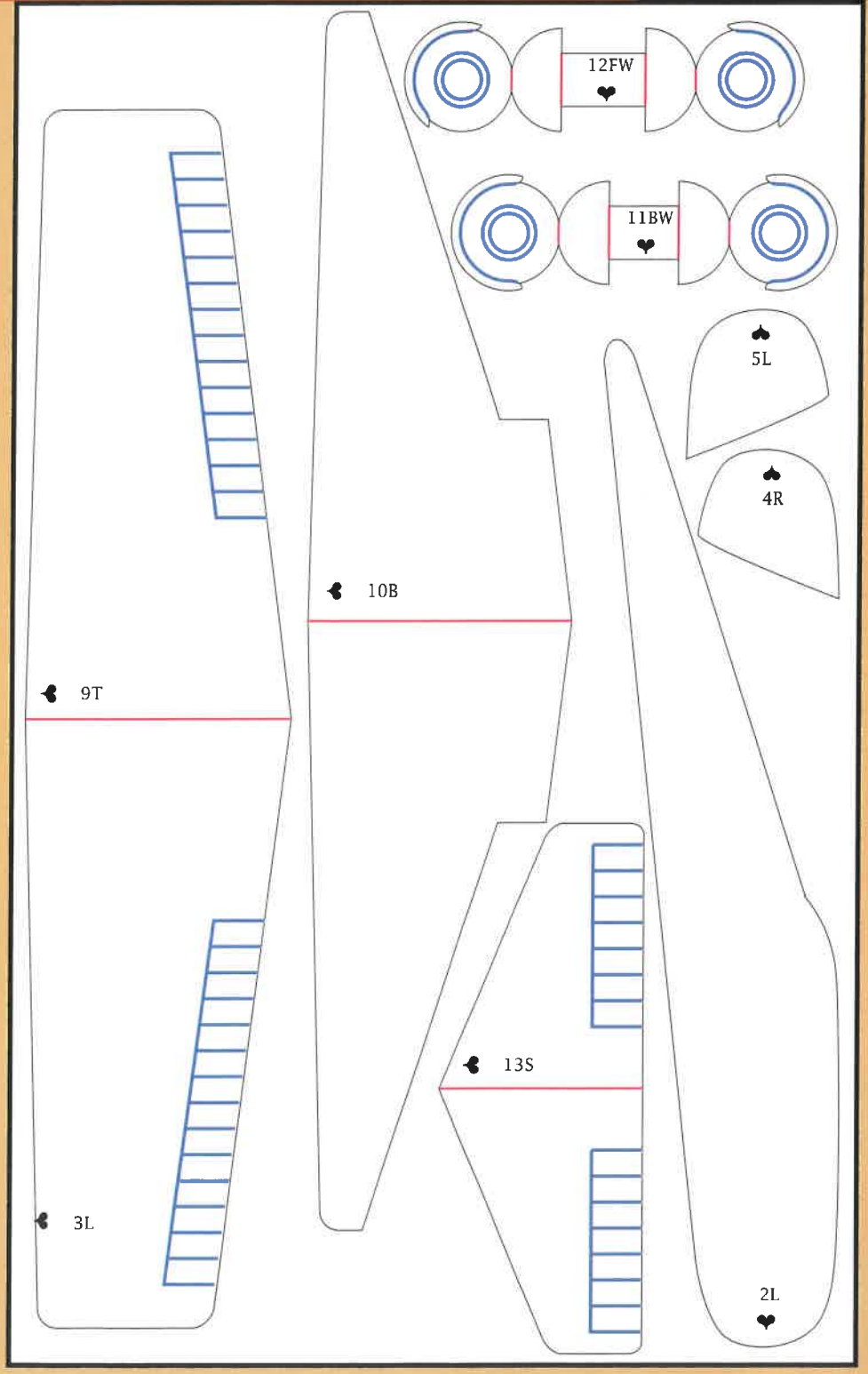
After the war another idea captured Taylor's imagination. Since aviation began there were those who dreamed of combining the airplane and the car into a single vehicle that could be flown to some destination and then driven on the ground from that point on. By 1949 Taylor had completed a prototype flying car – the Aerocar.

Some people thought that simply adding wings and tail to a regular car might work. But the problem with ground vehicles is that they are built boxy and heavy to with-

TAYLOR PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



stand traveling over
Such a vehicle would
powerful second eng
it through the air. Ta
to first custom build
and streamlined auto
lightweight aircraft n
car would have detac
and tail which could
a trailer and towed b
while traveling on th
same engine would p
vehicle in the air and
ground.

While this was a fasci
the work involved in
from one mode of tra
other made it imprac
except the enthusiast
number of these vehi
ever built and Taylor'
Aerocar in every gara
happened. However,
innovators have been
the Aerocar, and toda
taken up the challeng
such a vehicle.

BEDE

BD-5 J micro

LE DREAMS

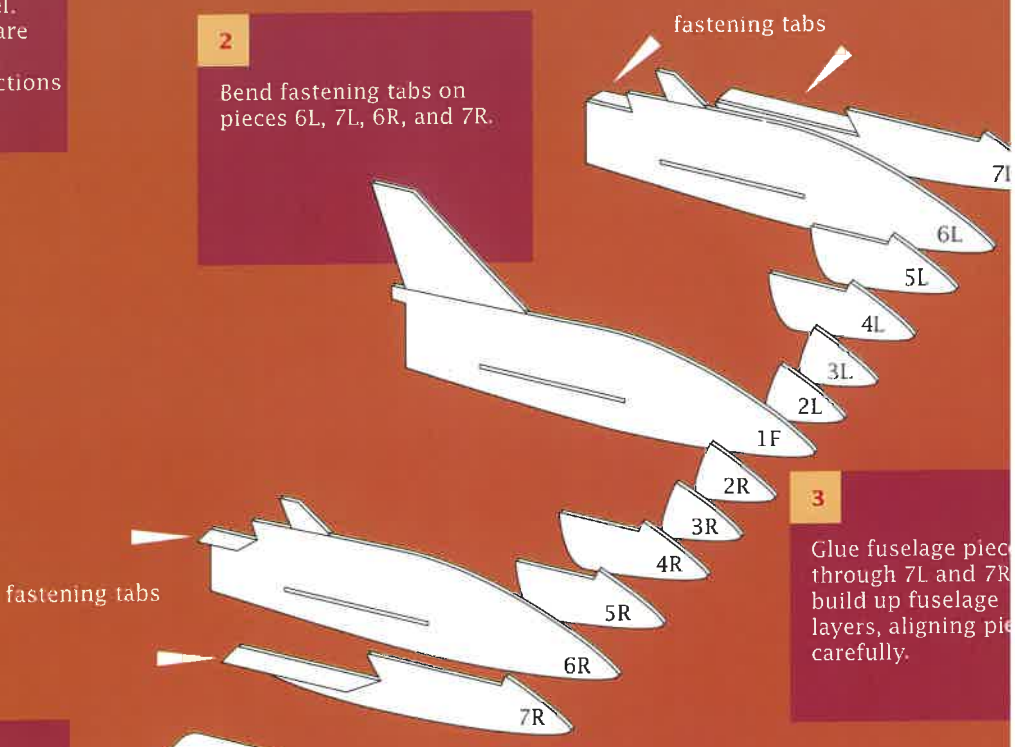
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 6L, 7L, 6R, and 7R.

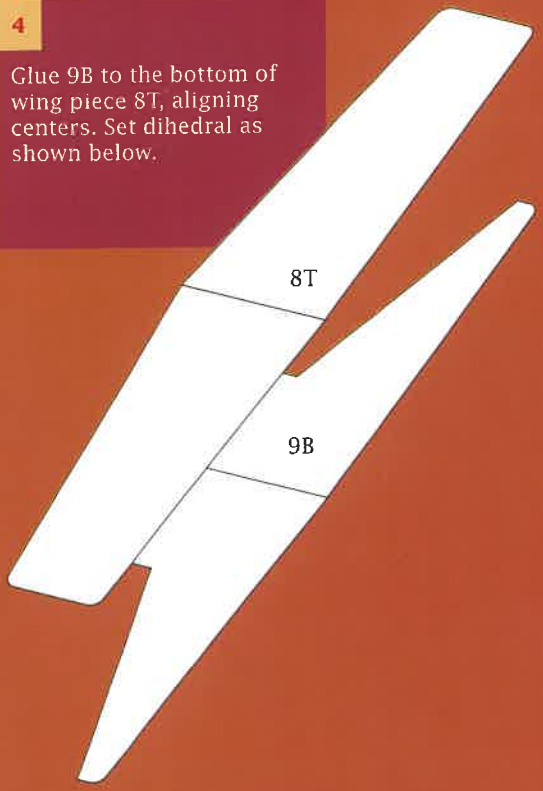


3

Glue fuselage piec through 7L and 7R build up fuselage layers, aligning pie carefully.

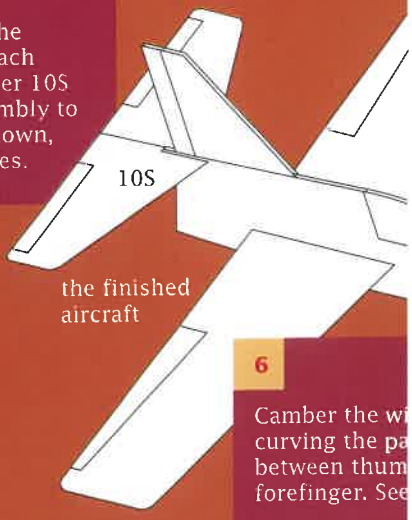
4

Glue 9B to the bottom of wing piece 8T, aligning centers. Set dihedral as shown below.



5

Applying glue to the fastening tabs, attach horizontal stabilizer 10S and the wing assembly to the fuselage, as shown, aligning center lines.



the finished aircraft

6

Camber the wi curving the pa between thum forefinger. See

camber:
point of maxi
20-30% from f

PIECES

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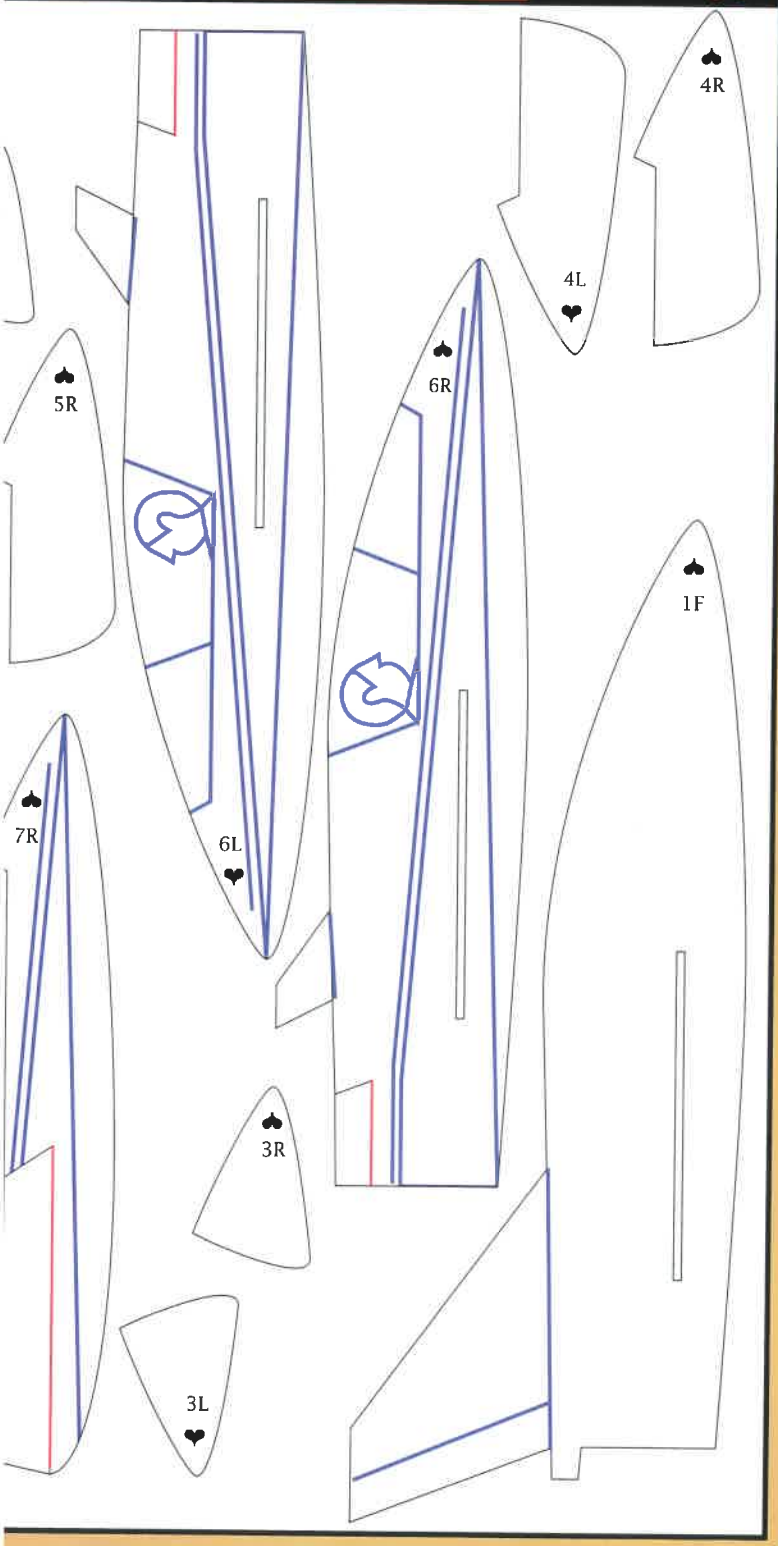
NOTE
CUT OUT PHOTOCOPY ONLY



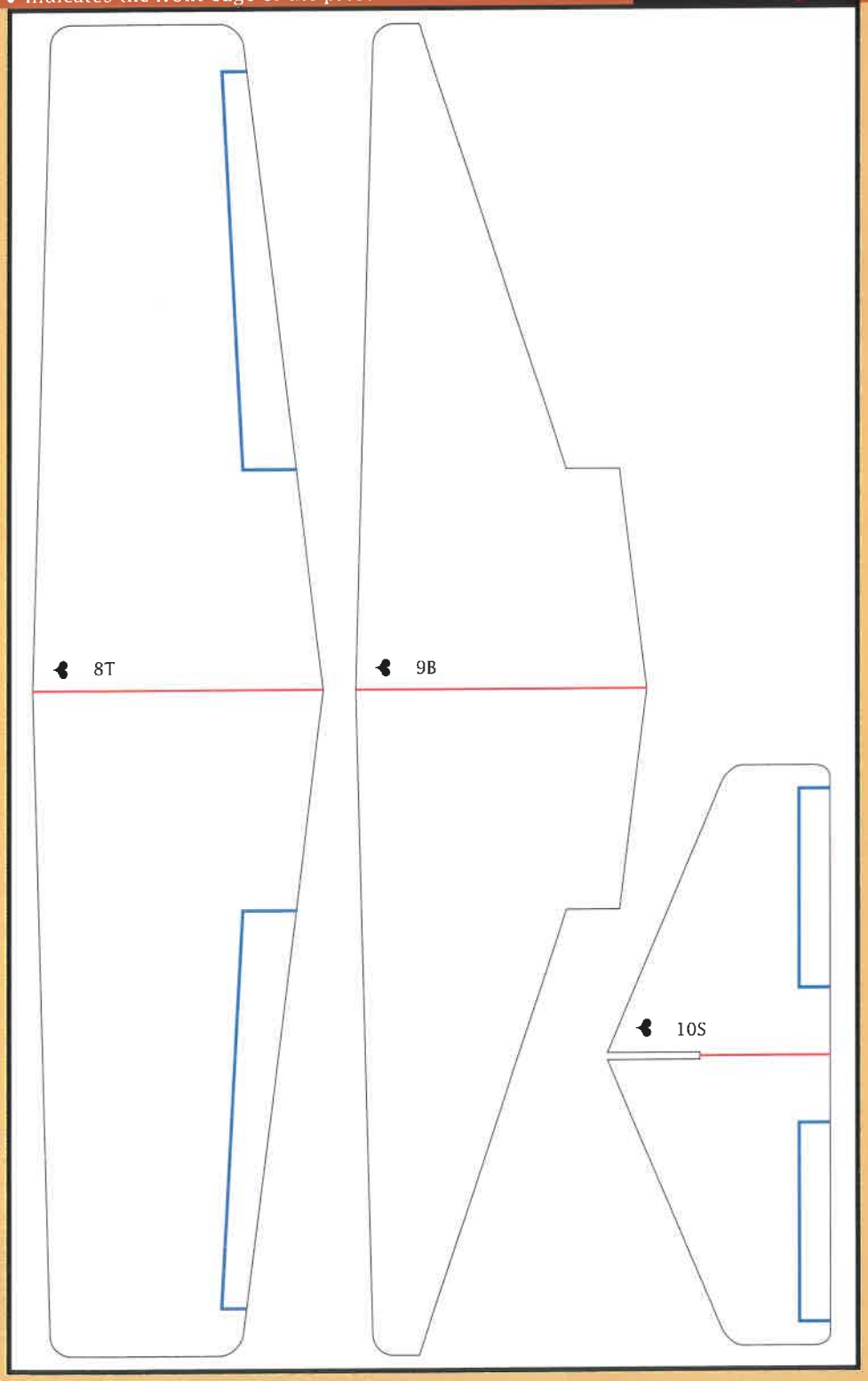
Jim Bede began work on a microsize aircraft in 1967. His imagination was fired by the idea of a low-cost easy-to-build personal sport airplane. The home building of aircraft was just beginning at that time because manufacturers of light airplanes faced ever greater costs and the prices of their airplanes rose to the point of being out of reach for the average private pilot. Since then many light sport aircraft are homebuilt from kits, much like model airplanes, with major components pre-made. But the making of the kit for sale requires a great deal of time and effort in order that the end product will be an airworthy aircraft. Bede was a thorough designer and proceeded with a rigorous test program for the BD-5. Unfortunately, things did not go well.

From the outset there were problems of one kind or another, ranging from stability, to the construction of the airframe, to the

BEDE PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



performance of the e
changes to the origin
were called for – inst
posites, metal was us
airframe; instead of a
conventional tail was
ous other changes we
well. All this took yea
and early enthusiasts
skeptics. Yet while th
on Bede was working
ambitious project – a
version of this micro

The dream of a sky fu
never happened, yet
ible little plane still s
of aviation enthusias
mystique has formed
machine. Adding to i
was the appearance c
version of the jet in t
James Bond movie *Oc*
Those who have flow
say that, although no
fainthearted, it is a fi
requiring skill and pr

MONTGOLFIER balloon

non-flying model

E SIZE

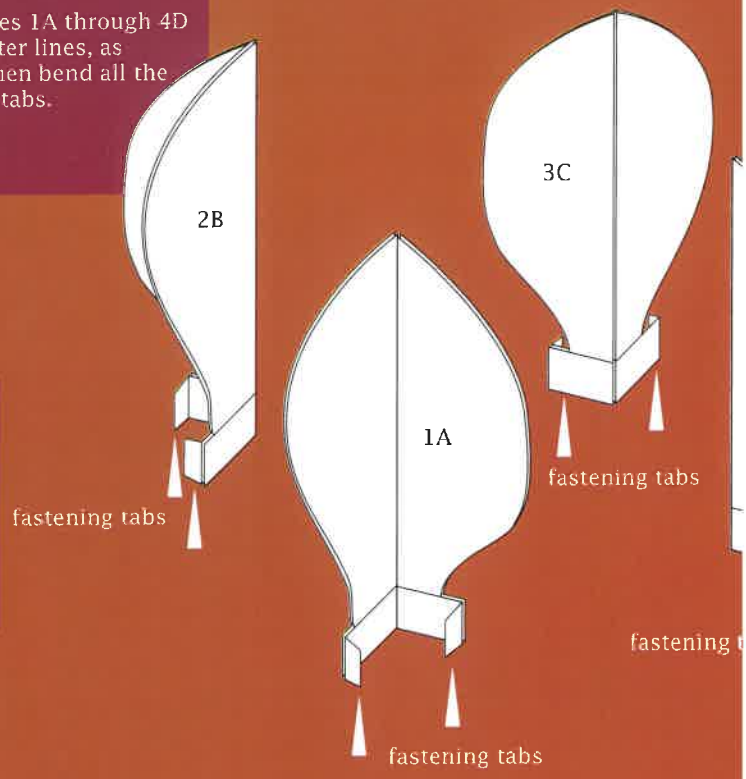
EXPLODED

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

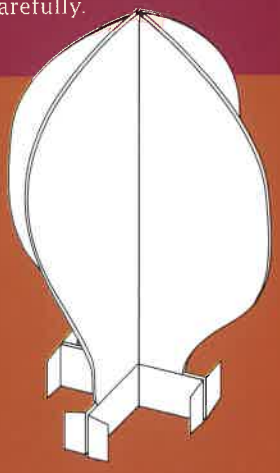
2

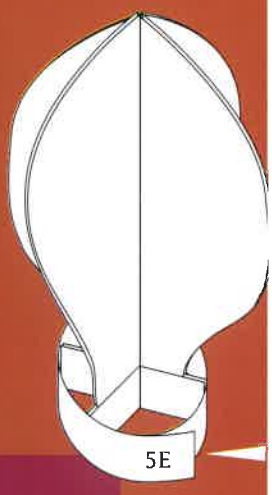
Bend pieces 1A through 4D along center lines, as shown. Then bend all the fastening tabs.



3

Glue pieces 1A through 4D together to make the main balloon assembly, as shown. Align edges carefully.





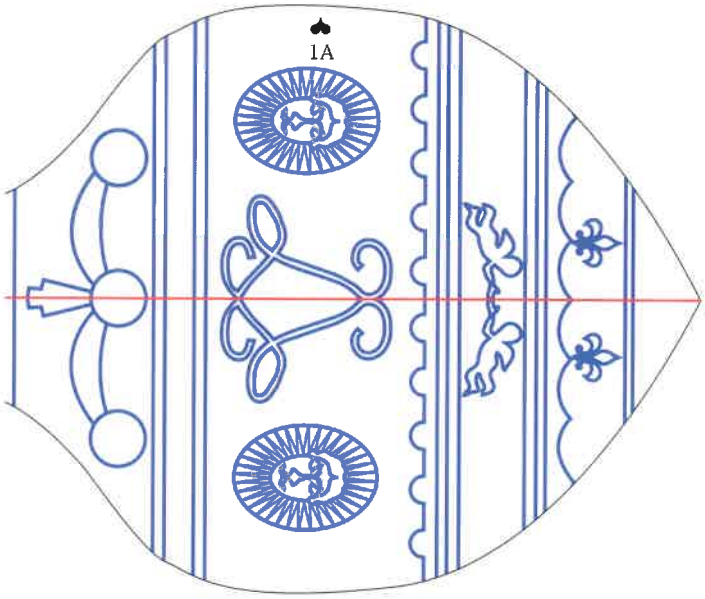
4

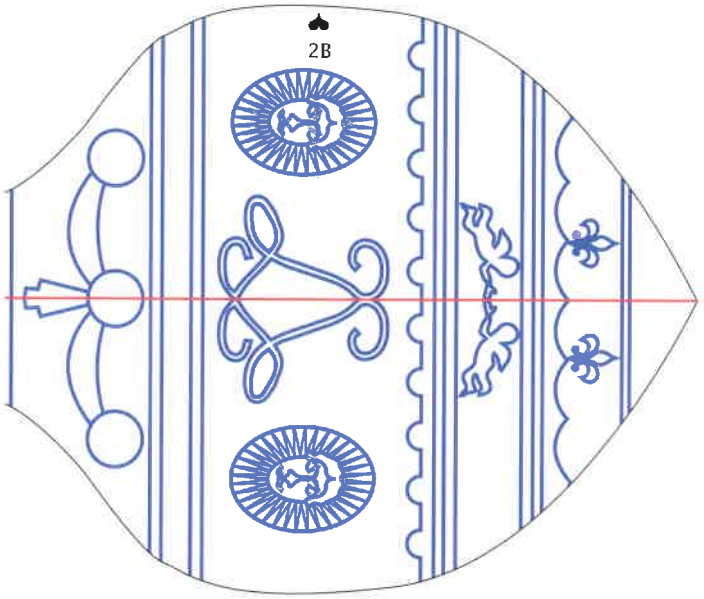
Applying glue to the fastening tabs on the main assembly and on the joining strip 5E, wrap strip around the base of the main assembly to finish the model balloon.

PIECES

own in black.
ed.
es as guides for adding details to the aircraft.
ont edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY





French man Joseph Montgolfier observed that soot and embers floated up in the smoke of an open fire. He also noticed that a shirt left to dry near an open fire billowed out from the rising smoke. This led him, in 1782, to experiment holding a cloth bag over a fire in an attempt to make it rise. To his delight it lifted skyward.

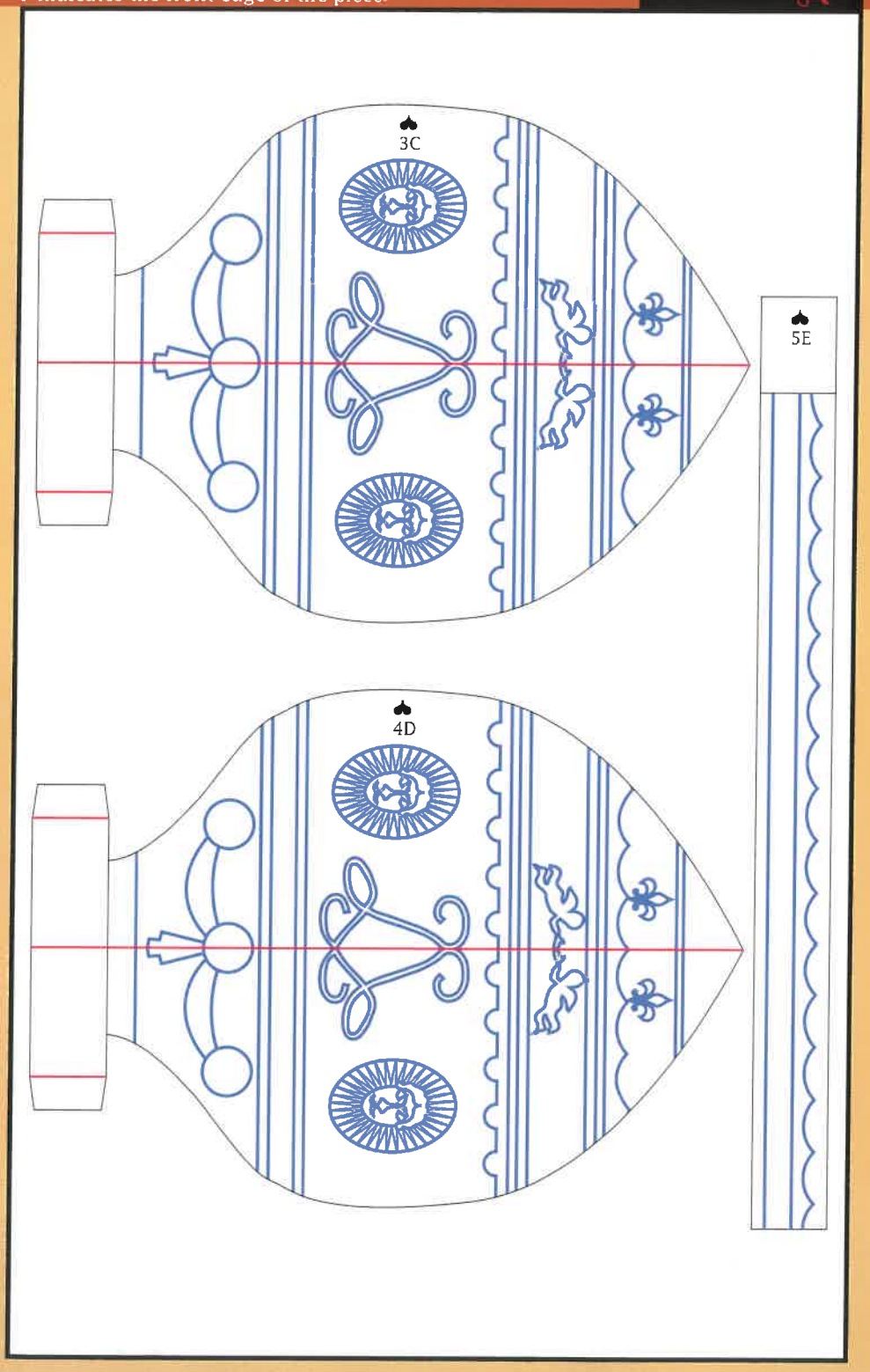
Secretly he and his brother Jacque experimented with larger and larger bags. After about a year they built a large balloon that they calculated could lift more than 400 pounds (200 kg). A straw fire was built beneath it and upon release the balloon rose smoothly to about 1000 feet (300m) and floated across several fields before landing. Only after this success were they ready to disclose their work.

In the autumn of 1783 they were asked to demonstrate their invention before the king and queen of France. For this occasion they built

MONTGOLFIER PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- ♠ Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY

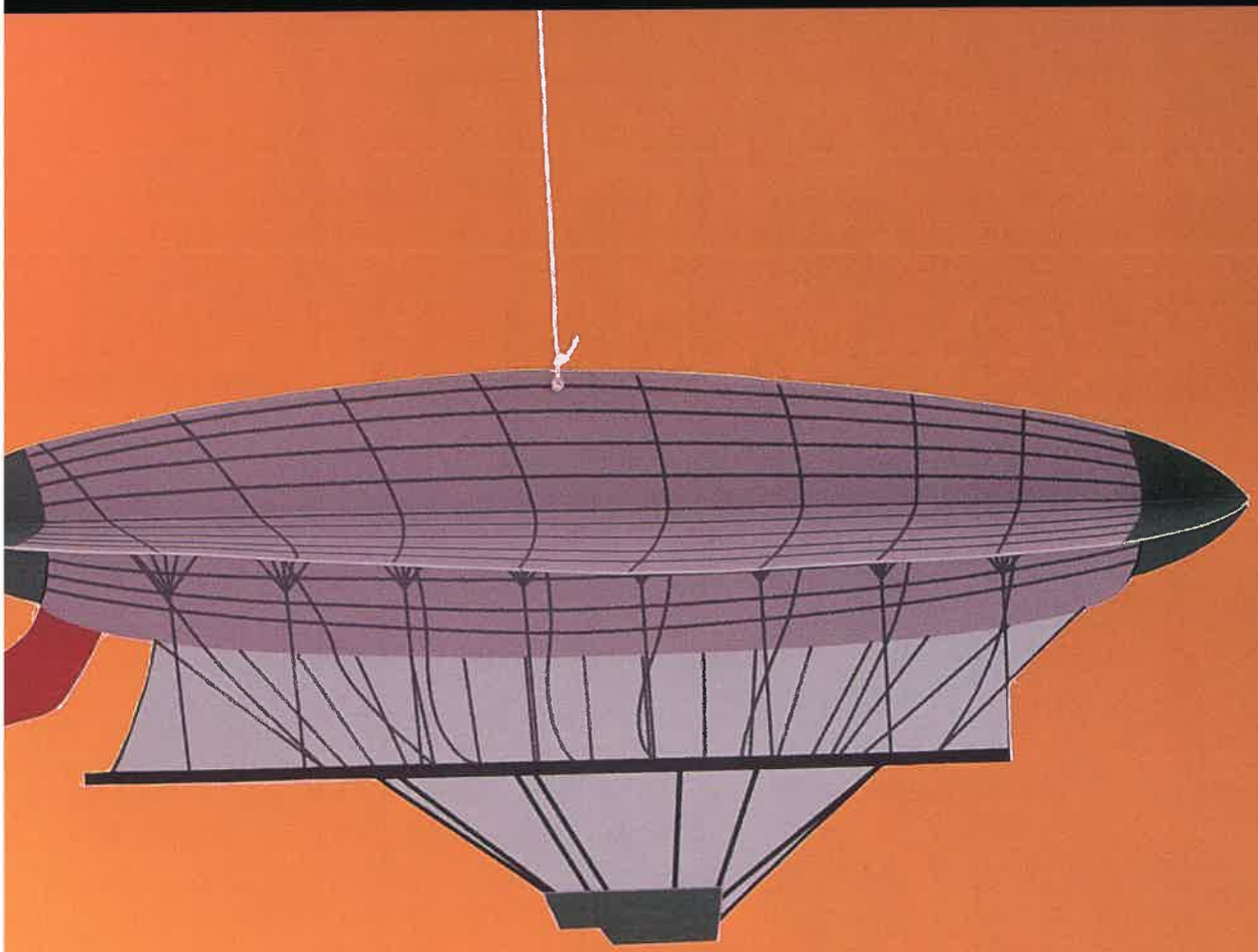


a brightly decorate
measured 41 feet (1
eter. A wicker cage
beneath the balloor
rooster, and a duck
inside. The flight, s
palace of Versailles,
minutes and these
the first living creat
balloon. Some time
de Rozier climbed a
became airborne, b
sake the balloon rer
for this flight.

A month later, howe
the Marquis d'Arlan
first untethered hur
larger and more str
balloon. The 49 foo
had a wicker gallery
base and a brazier f
the flight, When the
balloon rose gently,
the city of Paris high
heads of jubilant cr
landing 25 minutes
year balloon ascents
place in several othe

non-flying model

GIFFARD
dirigible



E SIZE

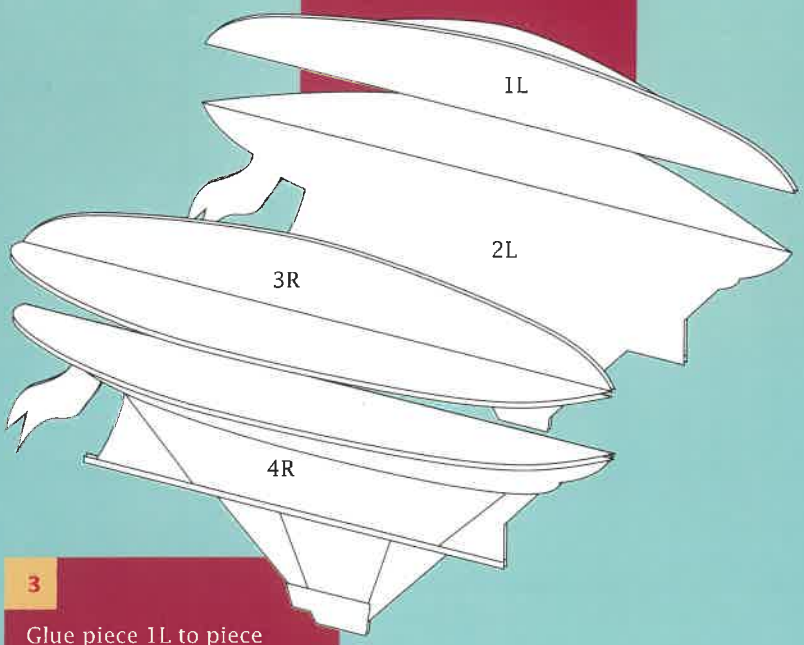
EXPLODED

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

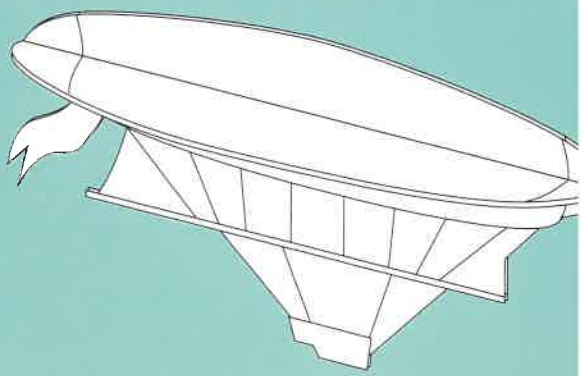
2

Bend pieces 1L through 4R along center lines, as shown.



3

Glue piece 1L to piece 2L and 3R to 4R, to make left hand and right hand halves, aligning pieces carefully. Then glue halves together to complete the aircraft.

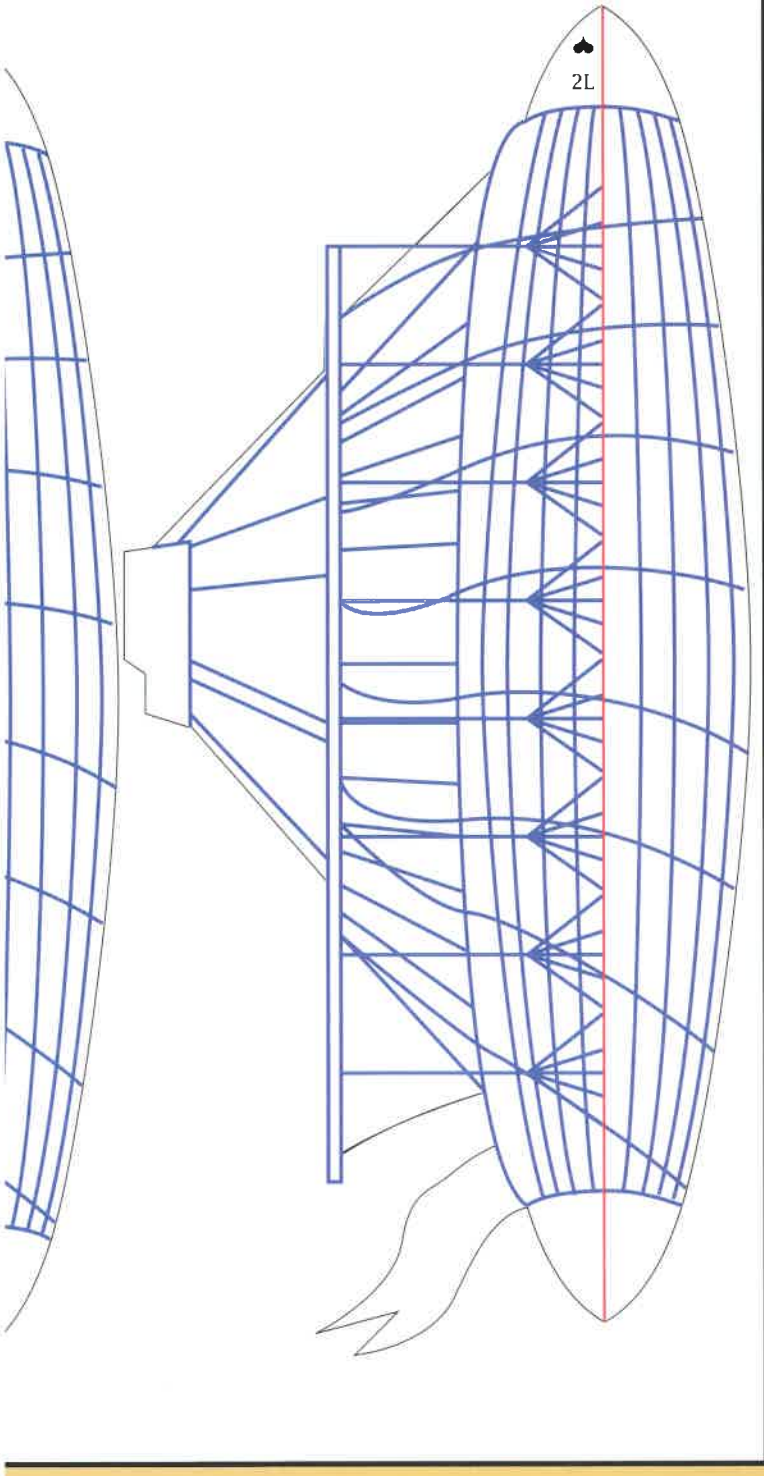


the finished aircraft

PIECES

wn in black.
d.
es as guides for adding details to the aircraft.
nt edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



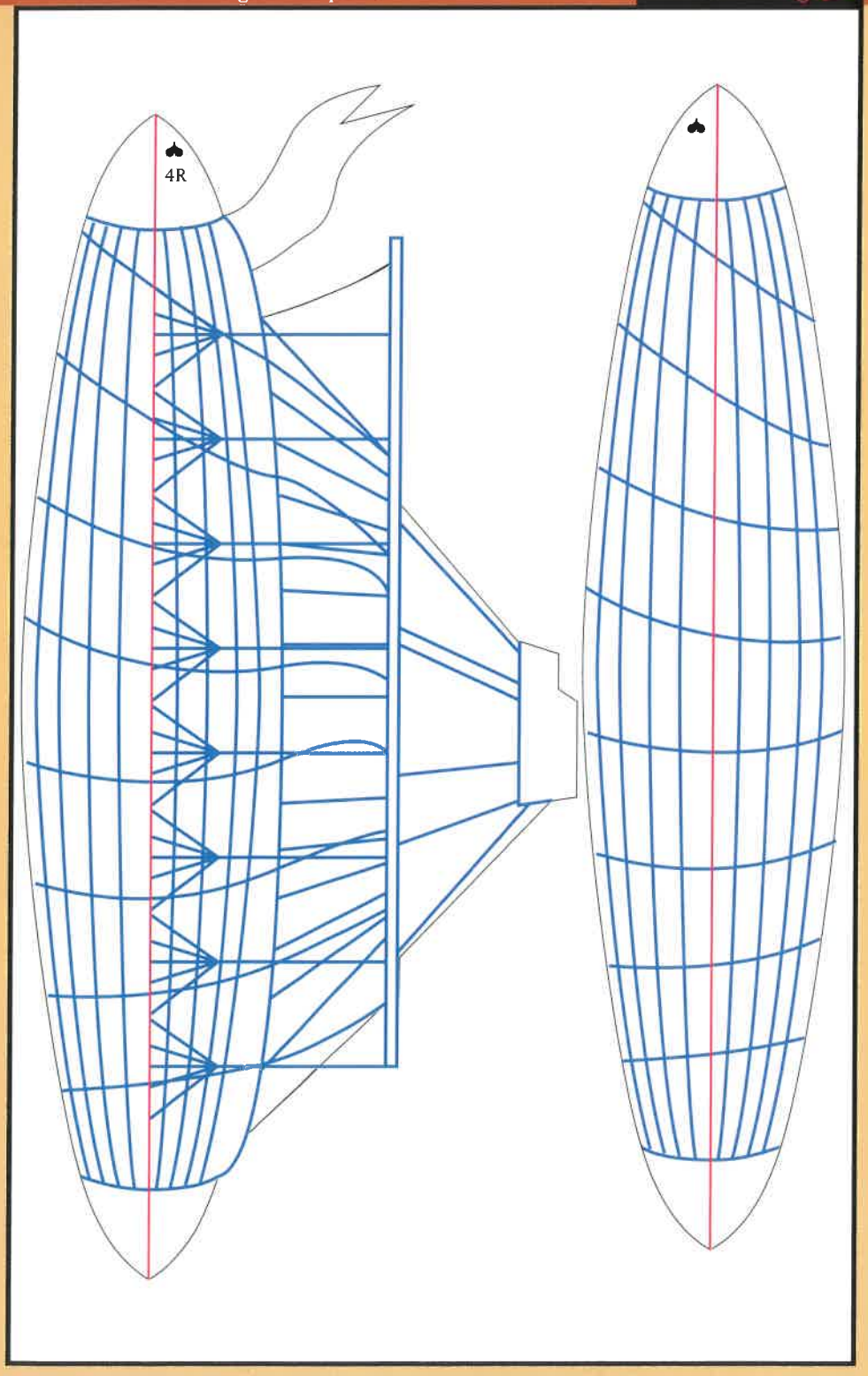
Hot air balloons, although large in size, were relatively simple machines. They were limited in their usefulness, however, because they depended entirely on wind for travel across country. As well as hot air balloons, hydrogen filled balloons were also being made. These were lighter than air and floated of their own accord, but required a more complicated arrangement of two bags, one inside the other for both hydrogen and compressed air, not to mention water ballast. In 1784 an attempt was made to fit a manually-turned propeller to a hydrogen balloon to make a dirigible – a steerable propelled airship. At first this proved unsuccessful. The size was incredible. One of these dirigibles would have required a crew of 80 individuals just to man the propellers and sails.

Over the years different shapes and sizes of airships were made

GIFFARD PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



and in 1852 Frenchm
Giffard successfully f
foot (44 m) lozenge-s
hydrogen-filled airshi
by a 3 horsepower ste
His dirigible had a fle
envelope covered in a
with the engine and o
suspended in a gondo
neath. This arrangem
envelope above and g
crew and passengers
became the standard
airships.

Traveling at a speed o
hour (8 kph) Giffard n
course of about 17 mi
which was the first su
manned, powered, an
flight. Incredibly, this
before Cayley's coach
the first successful st
short glide in a heavie
winged aircraft. Giffar
the course for many y
experiments with ligh
flight that rivaled the

ZEPPELIN airship

non-flying model

LE SIZE

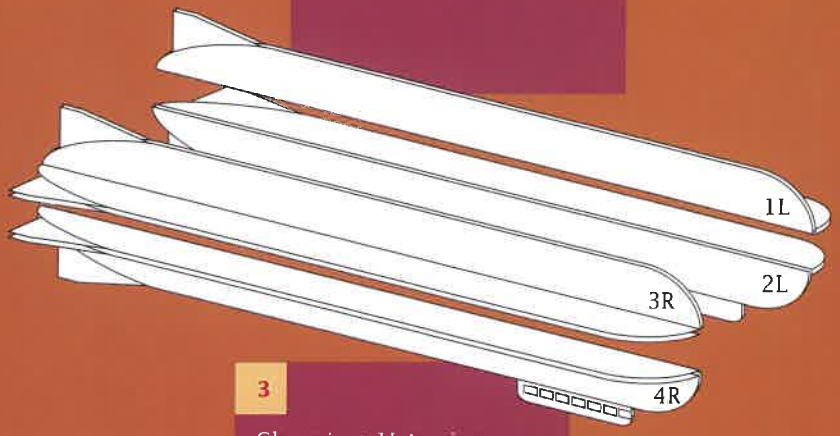
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

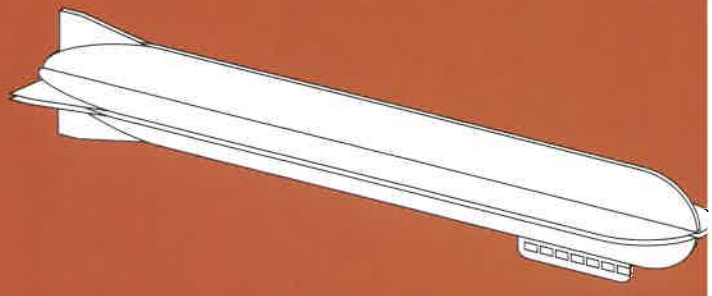
2

Bend pieces 1L through 4R along center lines, as shown.



3

Glue piece 1L to piece 2L and 3R to 4R, to make left hand and right hand halves, aligning pieces carefully. Then glue halves together to complete the aircraft.



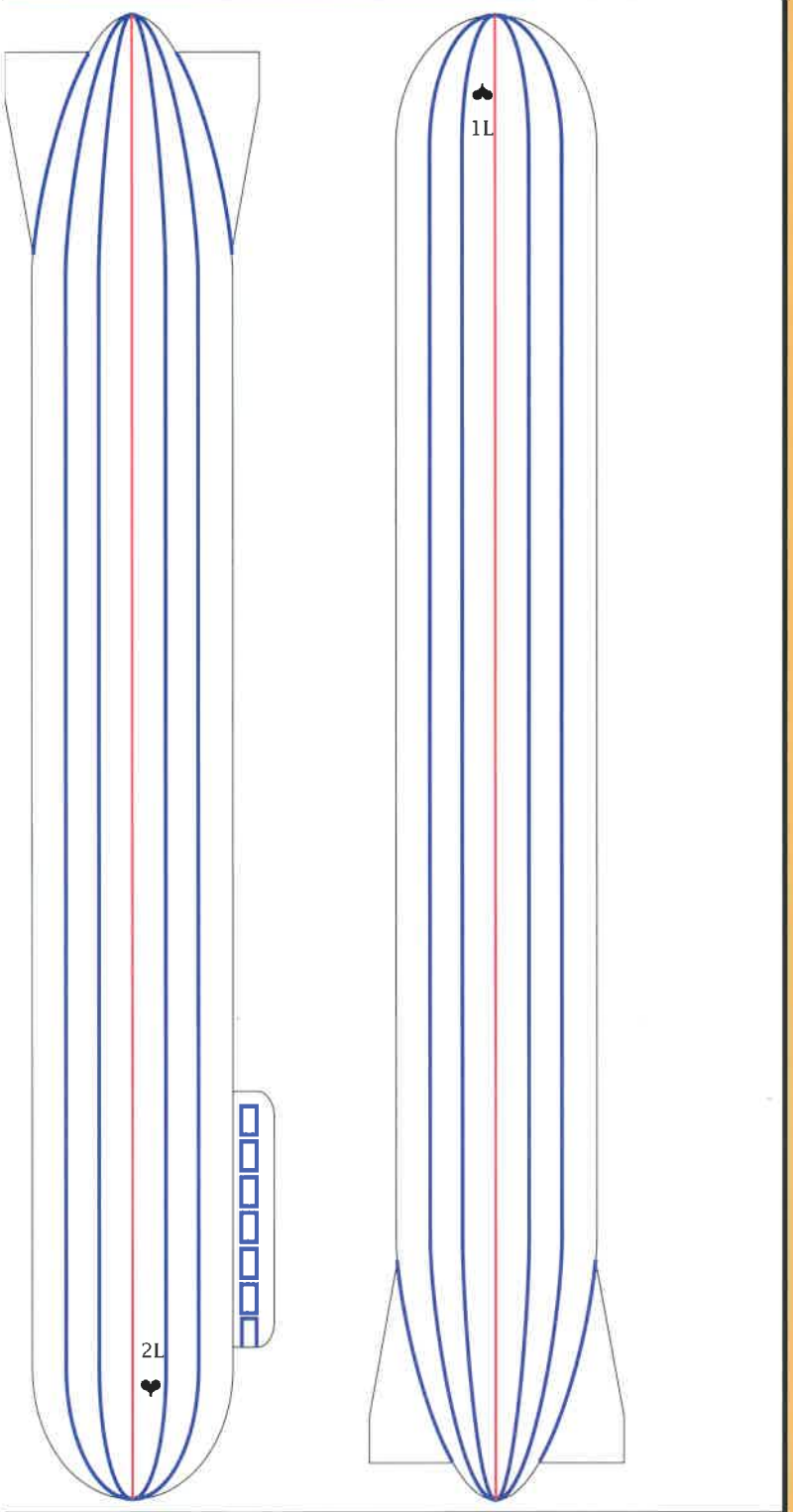
the finished aircraft

PIECES

zeppelin

hown in black.
red.
ines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



Count Ferdinand von Zeppelin was a big thinker. From the outset he conceived of enormous airships – great flying cigars. His first airship measured some 400 feet (120 m) in length. From there they only got bigger, the biggest to measure an incredible 803 feet (245 m). To support such a length of flexible material Zeppelin conceived of an internal metal framework, something like an enormous bridgework, to replace the external rope shrouds. Germany had recently seen the invention of the first internal combustion engine and Zeppelin fitted this to his monsters.

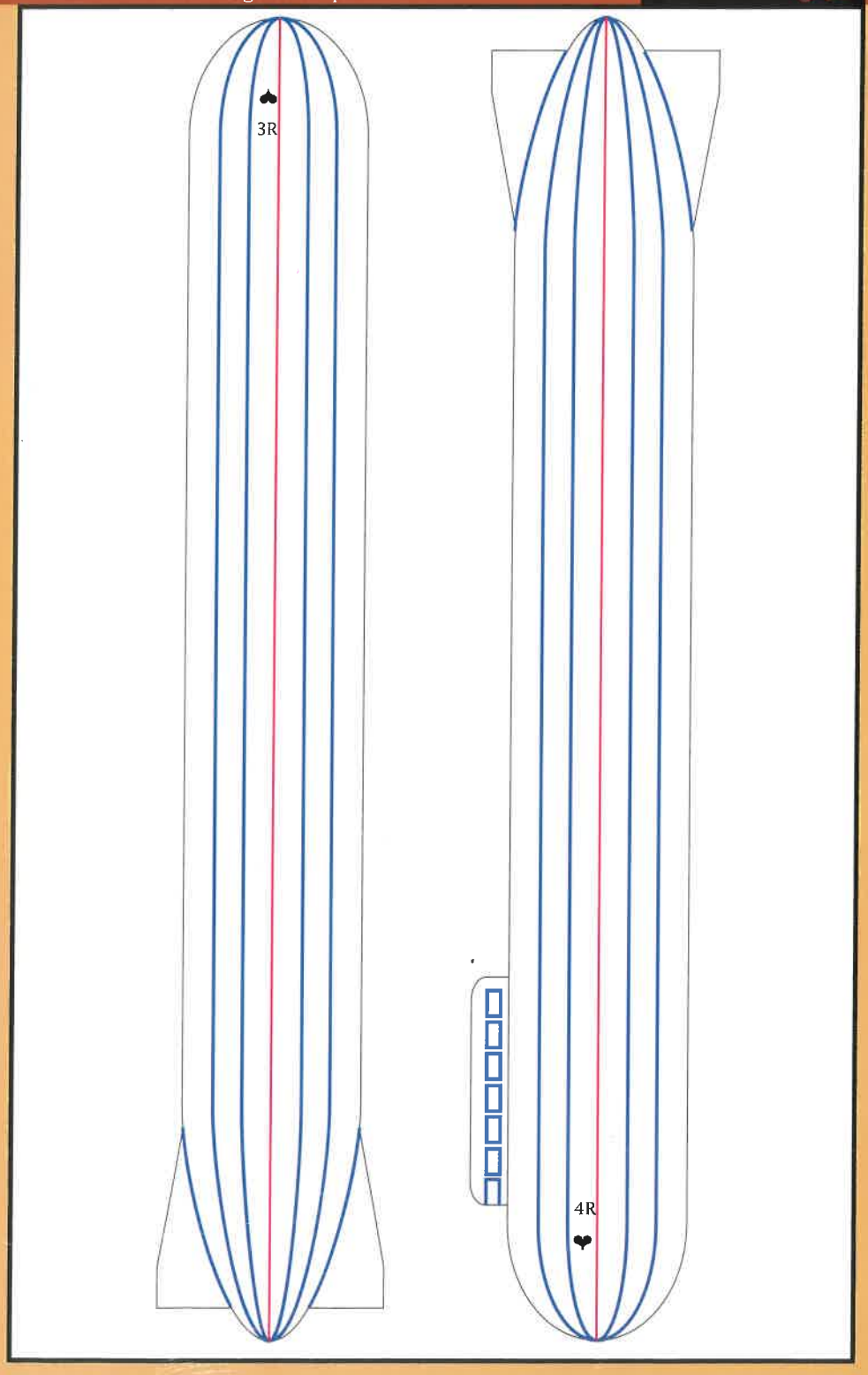
Early flight tests did not go well and it took him a long time to convince others that his large ships were airworthy. In the meantime, having spent all of his personal wealth on his dream, Zeppelin became broke. Surprisingly money poured in as people supported the Count, who had become a national hero. Zeppelin established the Zeppelin Foundation for the Promotion of Aerial Navigation, which allowed the company to go on to further develop and improve the rigid airship. Zeppelins became famous as the first airliners, circling the globe long before airplanes were able to do so.

Although these giant airships provided first-class service to rival that of the great ocean liners, because of their enormous size, airships were plagued with problems – mechanical

ZEPPELIN PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



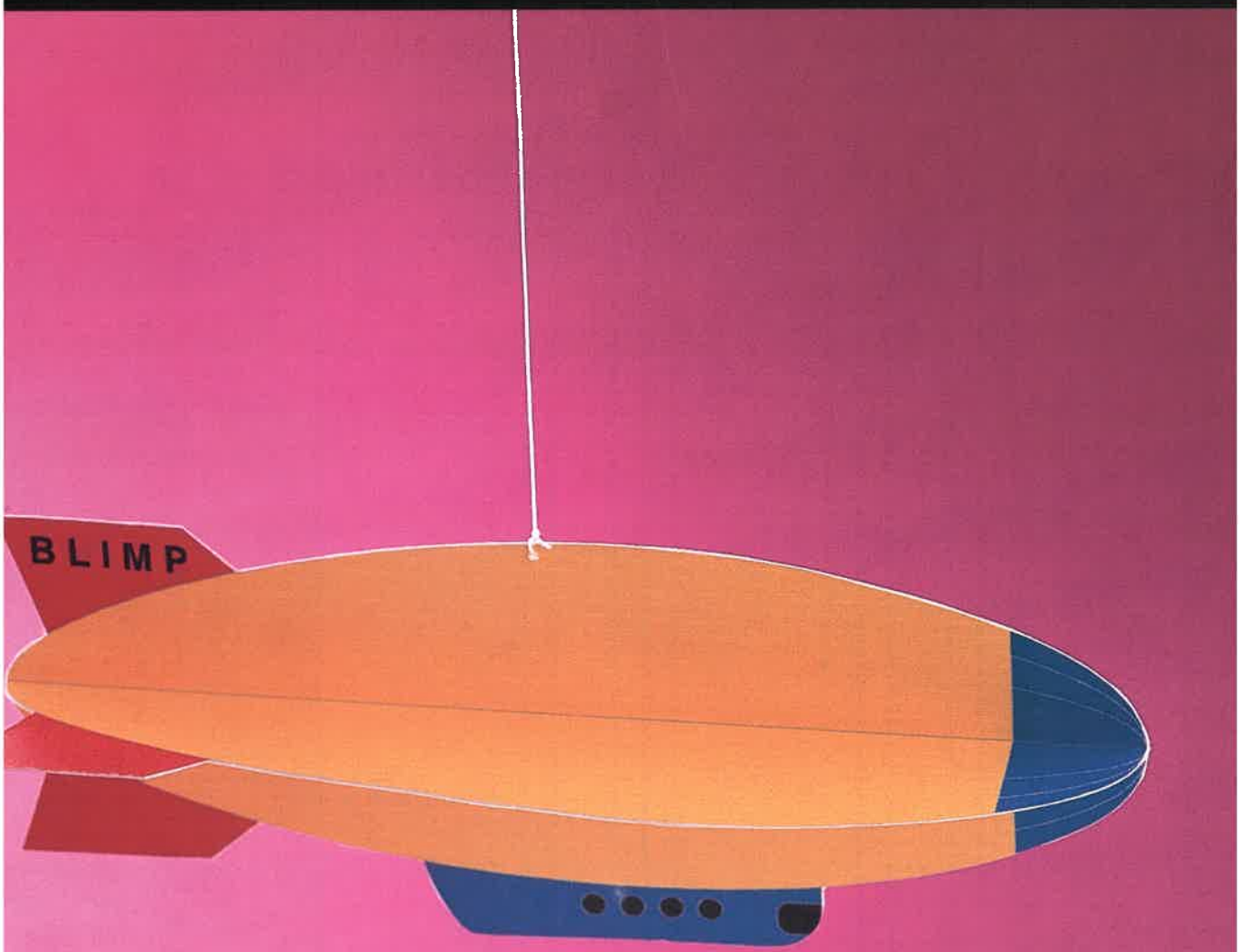
troubles, the effects o
weather, and not least
of fire imposed by the
of flammable hydroge
though non-flammabl
had been discovered a
used, it was in short s
hydrogen was more of
upon. Consequently m
ended their days in fla

Despite the dangers, C
continued with airshi
others had already giv
1936 Zeppelin launche
Hindenburg. It was lux
fast, traveling betwee
and the United States
under 50 hours. It was
Germany. Safety was p
Walkways were rubber
prevent sparks, no one
to bring on board mat
ers, and a special firep
lounge was provided.

Then in May of 1937, a
cessful flight from Fra
Jersey where it docked
Hindenburg suddenly,
caught fire, the flames
engulfing the entire sh
only 35 of the 97 peop
were killed in the conf
This accident caused t
lose confidence in airs
all further developmer
than-air commercial tr
ended.

GOODYEAR blimp

non-flying model



LE SIZE

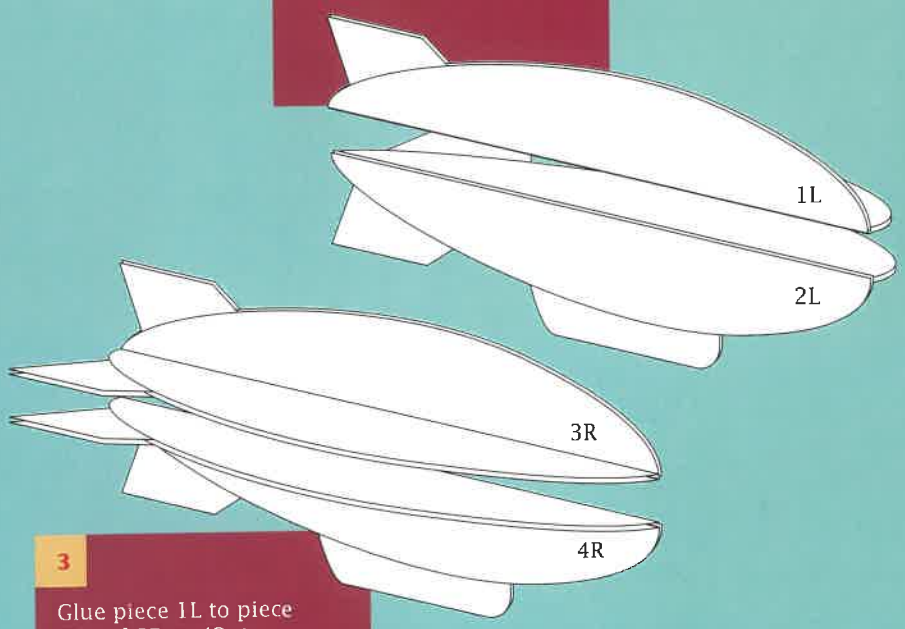
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

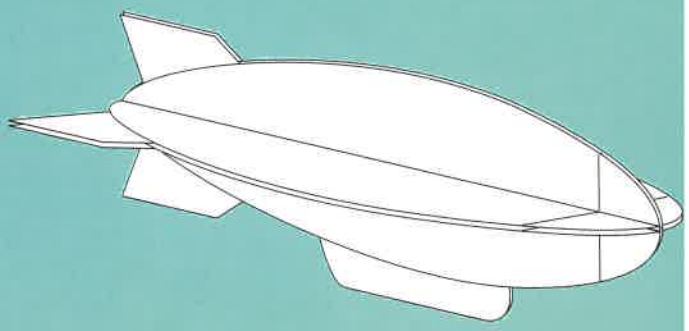
2

Bend pieces 1L through 4R along center lines, as shown.



3

Glue piece 1L to piece 2L and 3R to 4R, to make left hand and right hand halves, aligning pieces carefully. Then glue halves together to complete the aircraft.



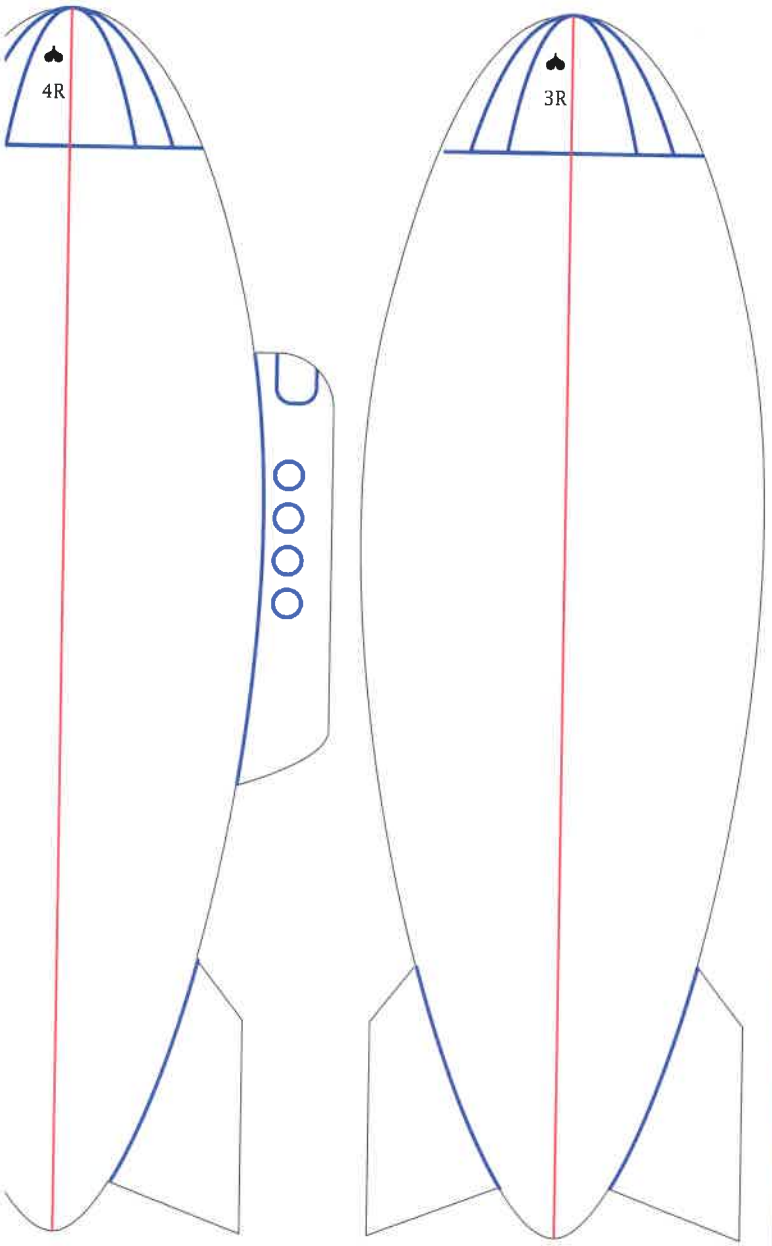
the finished aircraft

E PIECES

goodyear

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



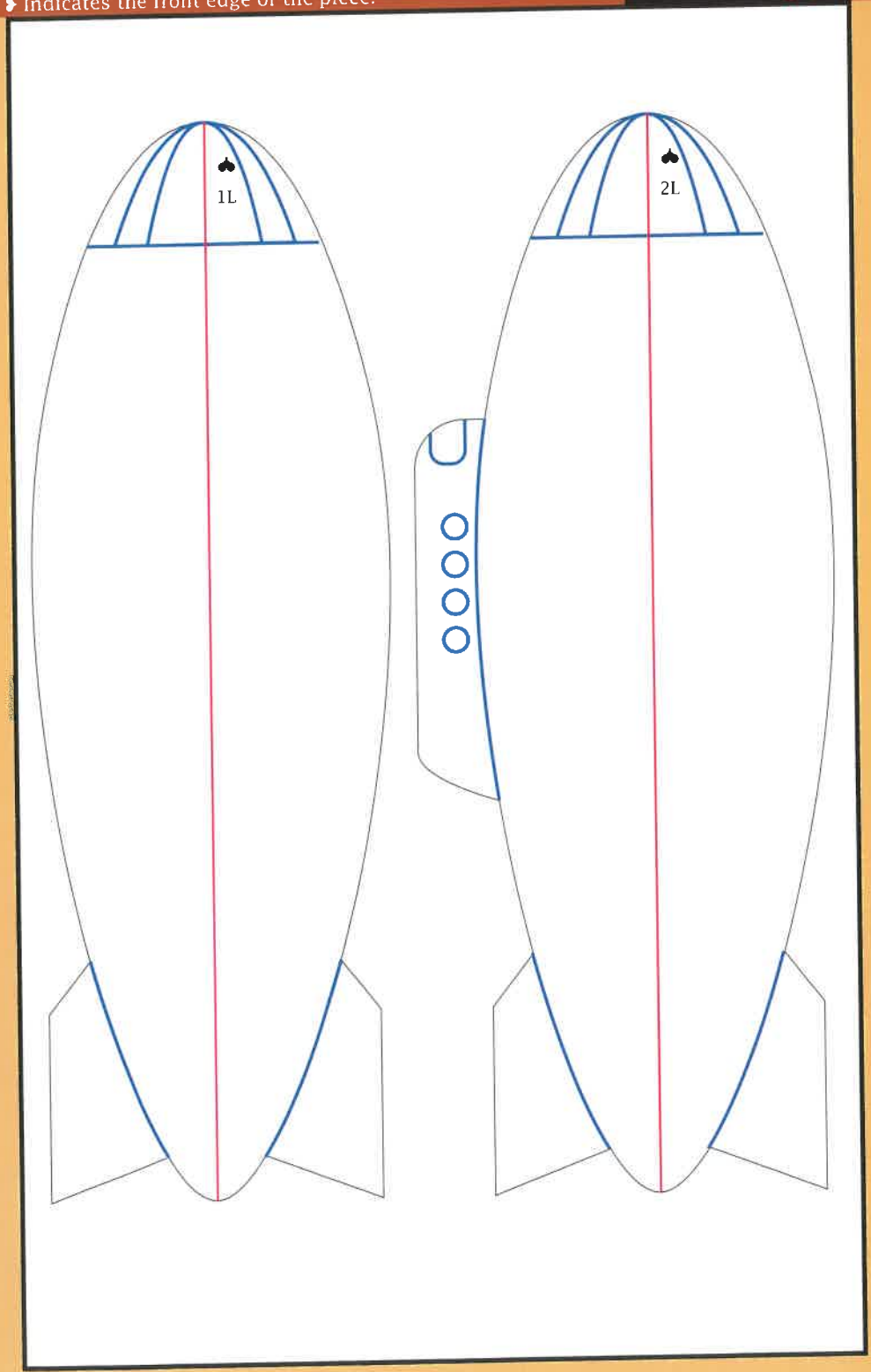
In the United States the Goodyear Tire and Rubber Company built airships, beginning in 1921 with the C7, which was used for coastal patrol by the Navy. From the outset American airships were filled with non-flammable helium gas, which was more expensive than hydrogen, but made airships safer from fire.

The Goodyear ships were at first non-rigid and were nick-named "blimps" from the fact that they were of B class and limp construction. Although rigid ships were built by this company, who even went into partnership with Zeppelin in 1928, Goodyear became better known for its blimps. Until 1935 a variety of rigid airships served in naval patrol. Thereafter patrol relied entirely on blimps. The American Navy used blimps for airborne early warning until 1962, when the last two Goodyear ZPG 3-W models were retired.

GOODYEAR PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



More recently Goodye
have taken on a differ
They have been scale
size and fitted with til
fan engines, making t
maneuverable and les
weather hazards. Now
all the high-tech navig
found on airplanes. In
today these ships are
quently by large numl
ple. Their most comm
overhead observation
tising at large-scale p
such as fairs and gam
short-range sightseei

Is there a broader fut
blimps? Because of th
improved reliability a
maneuverablity, they
being considered for
role as patrol ships, a
"sky cranes" in such c
logging in difficult-to
where helicopters are

BLERIOT monoplane

non-flying model
(will fly with wheels removed)

E ACHIEVEMENTS

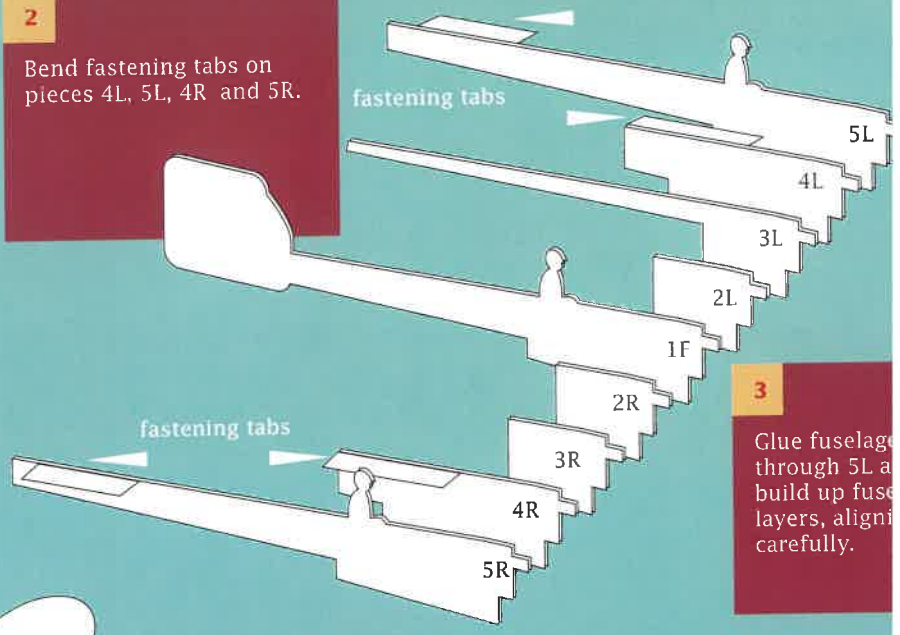
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 4L, 5L, 4R and 5R.

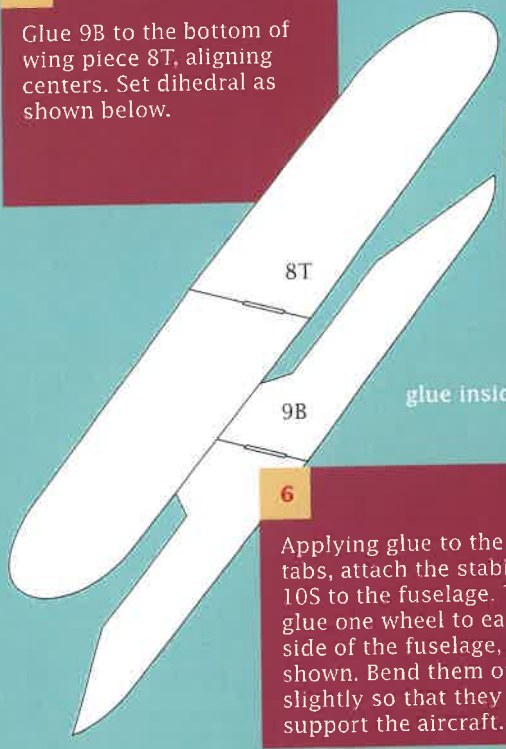


3

Glue fuselage through 5L a build up fuse layers, aligni carefully.

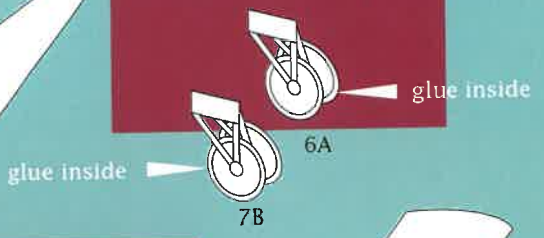
5

Glue 9B to the bottom of wing piece 8T, aligning centers. Set dihedral as shown below.



4

Glue the two wheel assemblies 6A and 7B.



8

Camber the curving the between thu forefinger. S

6

Applying glue to the tail tabs, attach the stabilizer 10S to the fuselage. Then glue one wheel to each side of the fuselage, as shown. Bend them outward slightly so that they support the aircraft.

the finished aircraft

7

Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines.

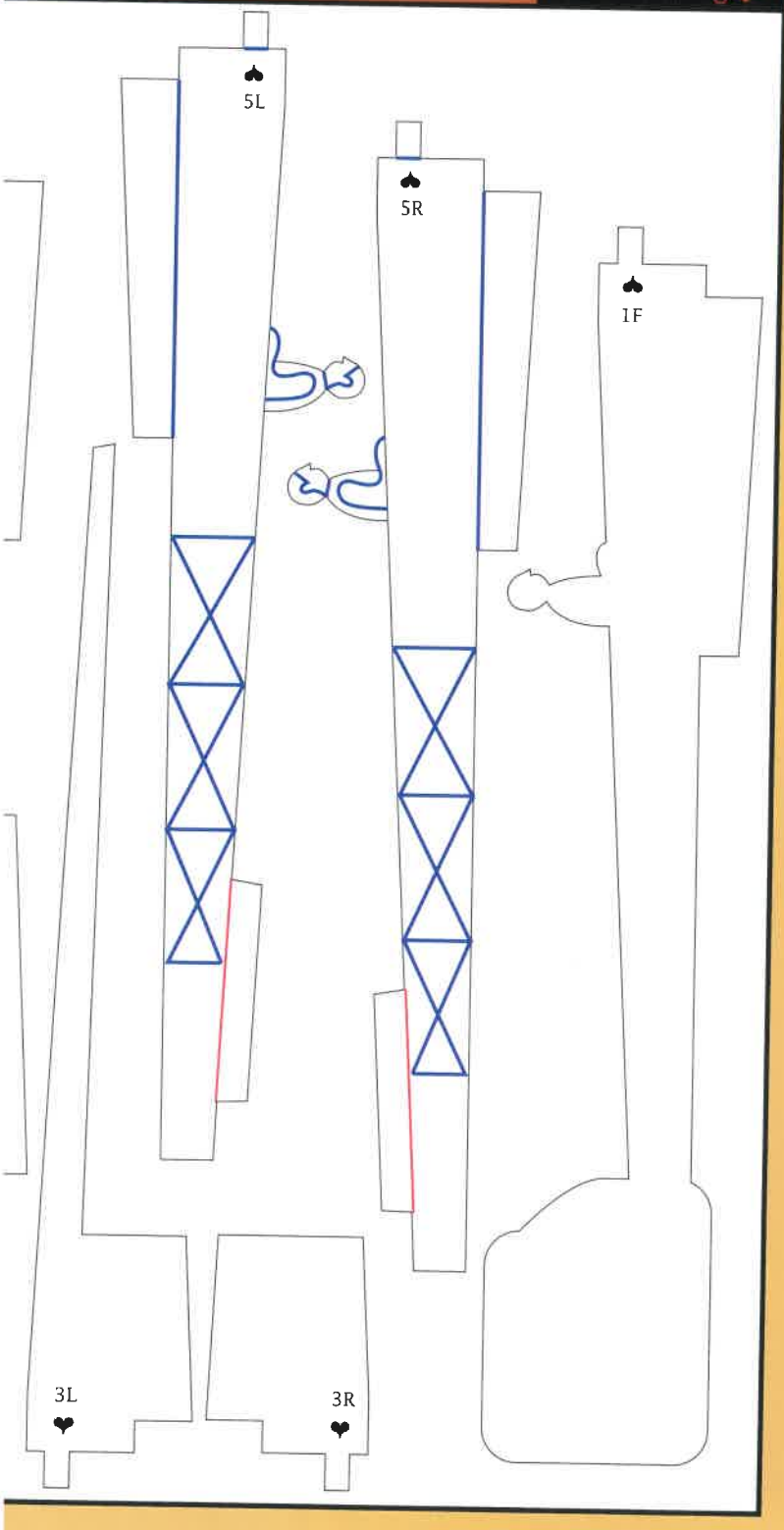
dihedral angle: wings 3

camber: point of maxim 20-30% from fr

E PIECES

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



bleriot

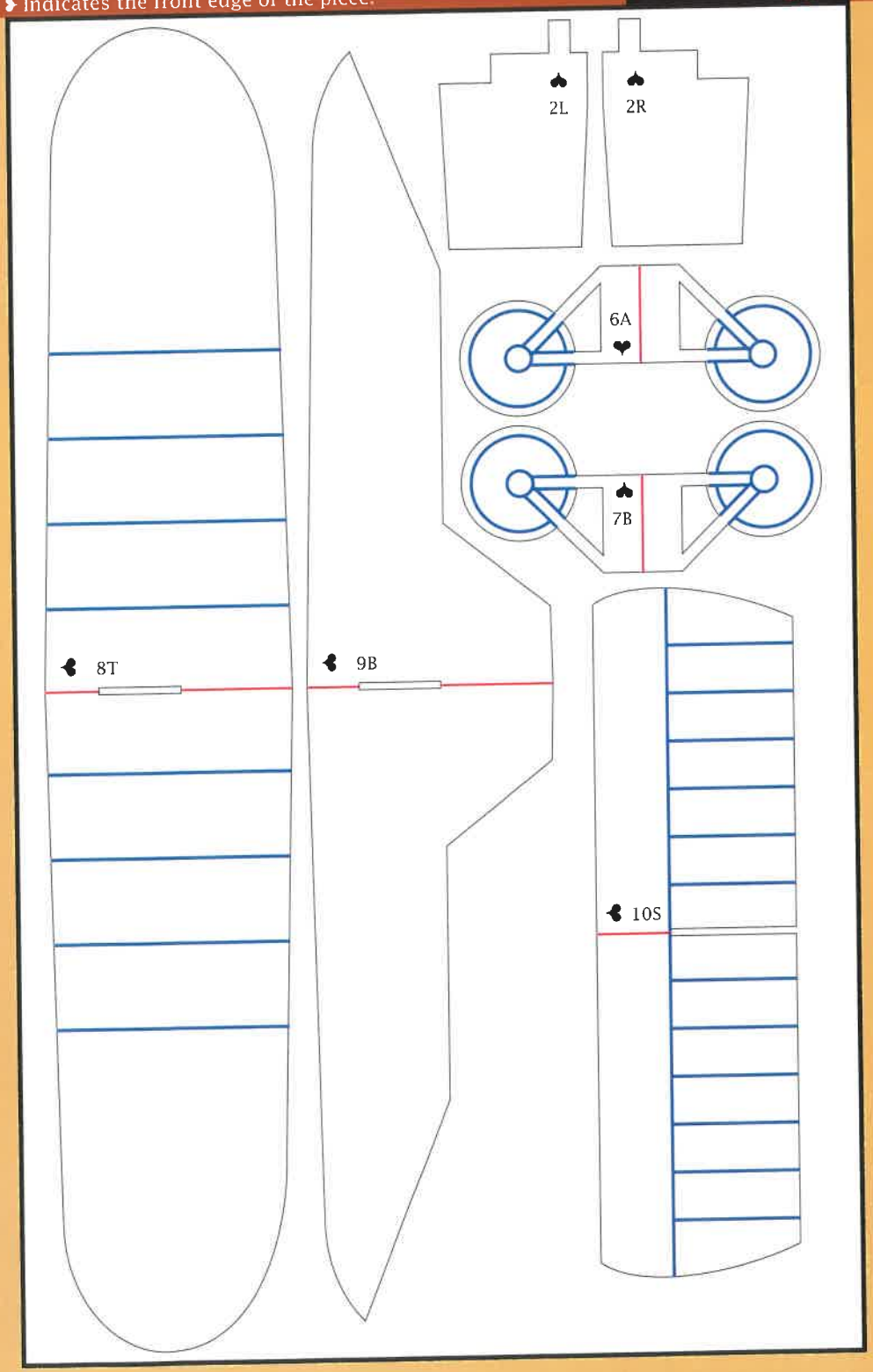
In 1903 successful sustained powered flight was achieved by Orville and Wilbur Wright, which spawned a flurry of invention and daring around the world. The Wright airplanes were biplanes modeled on the box kite of the day, a rigid cross-braced stucture having two pairs of wings. But Louis Bleriot of France had different ideas for aircraft. His designs were flimsy monoplanes that expressed his flambouyant and daring personality.

Louis Bleriot was not only a dreamer but also an achiever. As did other individuals in his day, he designed, built, and flew his own airplanes. This resulted in many crashes but knowledge was gained about flight through trial and error – a dangerous proposition in aviation. These aircraft designs were based on intuition more than on scientific knowledge. Incredibly, in Bleriot's career, he survived all but the last of thirty-three crashes.

BLERIOT PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY

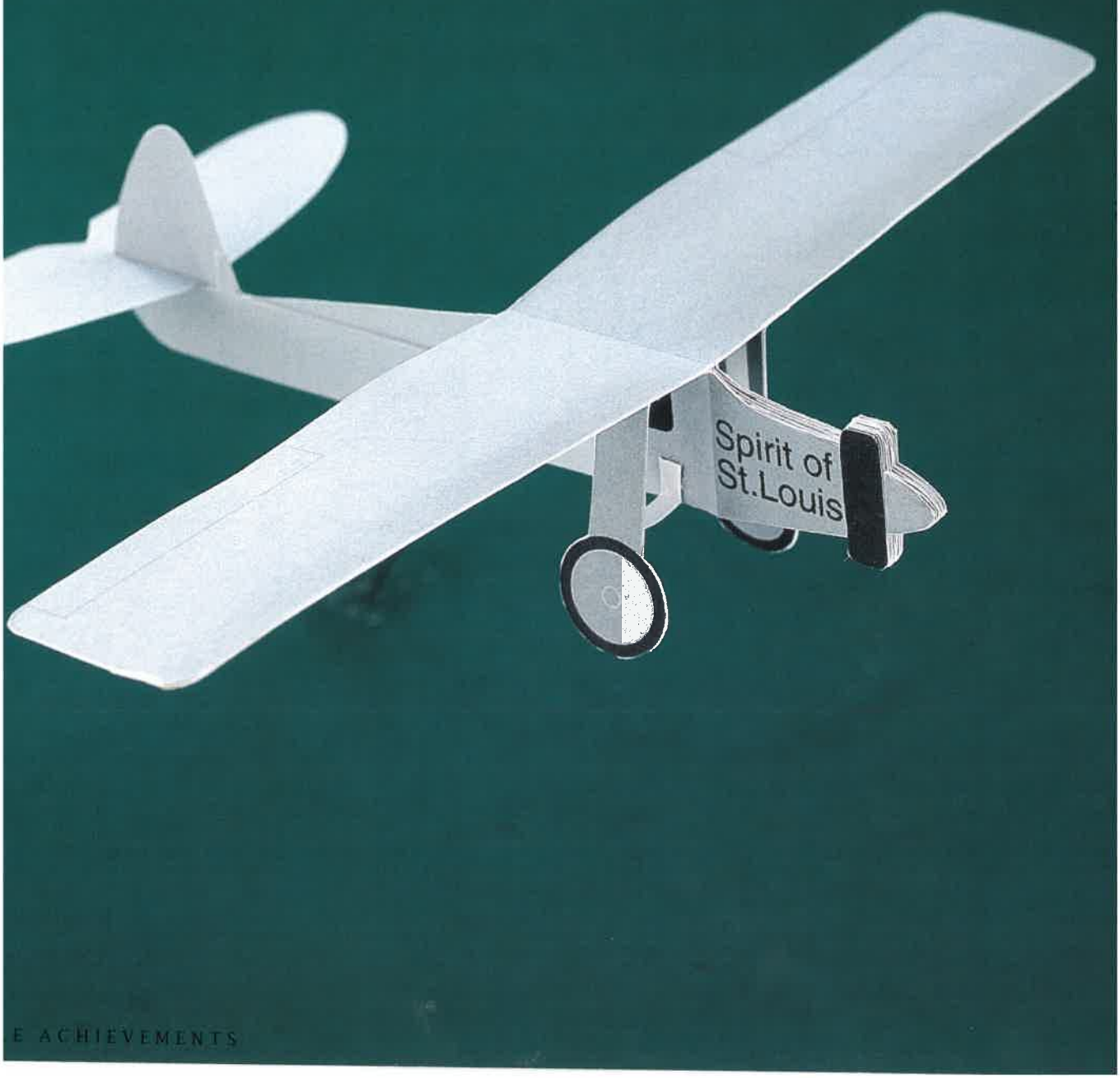


Bleriot's monoplane de
ahead of its time. Man
of the design were bui
and others. However, r
them broke up in fligh
the stresses on the air
greater than the streng
could be built into the
structures using the k
they had. Despite this
XI monoplanes were b
this monoplanes most
peared from the skies
1930s when stronger
could be built.

The greatest fame of t
monoplane came in 19
Bleriot changed the w
across the English Cha
Calais to Dover. News
day prophetically pro
England was no longe
because the protectio
Great Britain by the se
breached.

LINDBERGH
Spirit of St Louis

non-flying model
(will fly with wheels removed)



E ACHIEVEMENTS

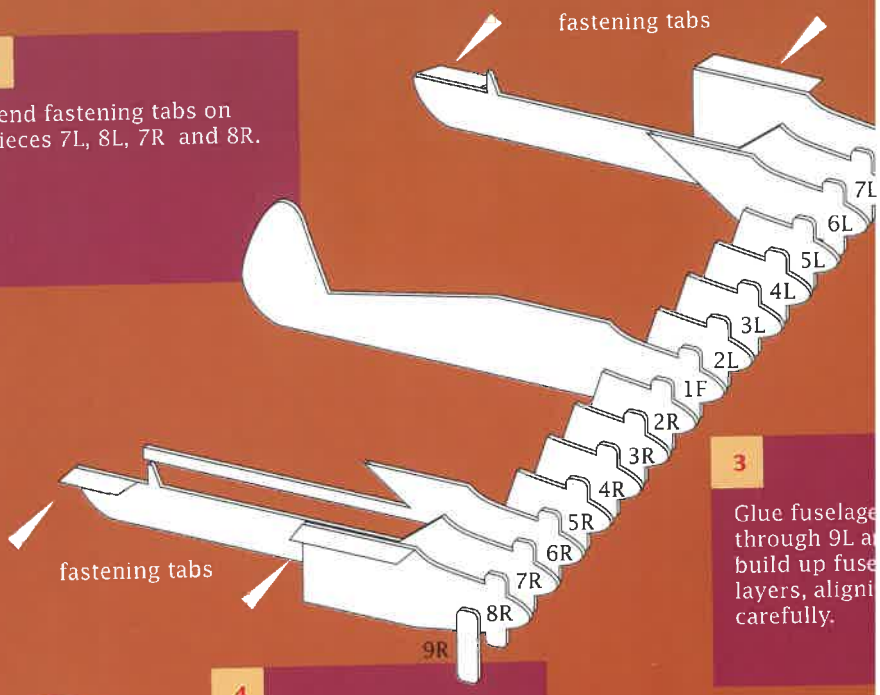
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 7L, 8L, 7R and 8R.

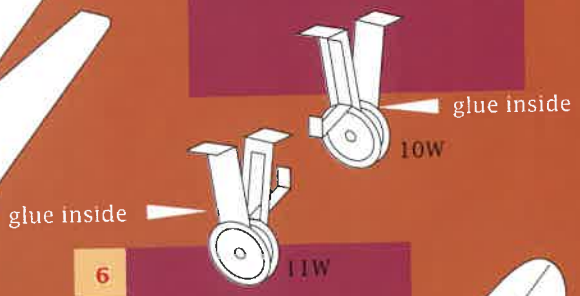


3

Glue fuselage through 9L a build up fuse layers, aligni carefully.

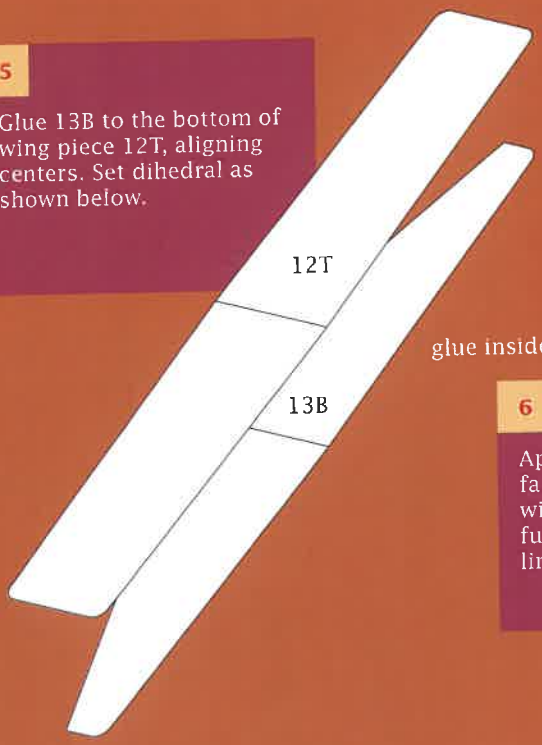
4

Glue the two wheel assemblies 10W and 11W.



5

Glue 13B to the bottom of wing piece 12T, aligning centers. Set dihedral as shown below.



6

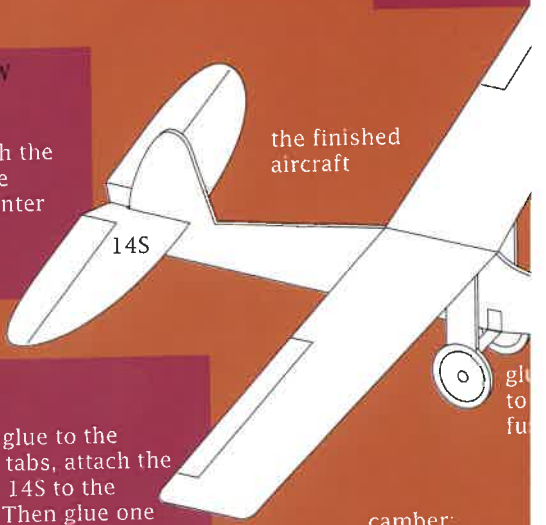
Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines.

7

Applying glue to the fastening tabs, attach the stabilizer 14S to the fuselage. Then glue one wheel to each side of the aircraft, as shown. Use wheel placement guides (pp62-63).

8

Camber the curving the between thu forefinger. S



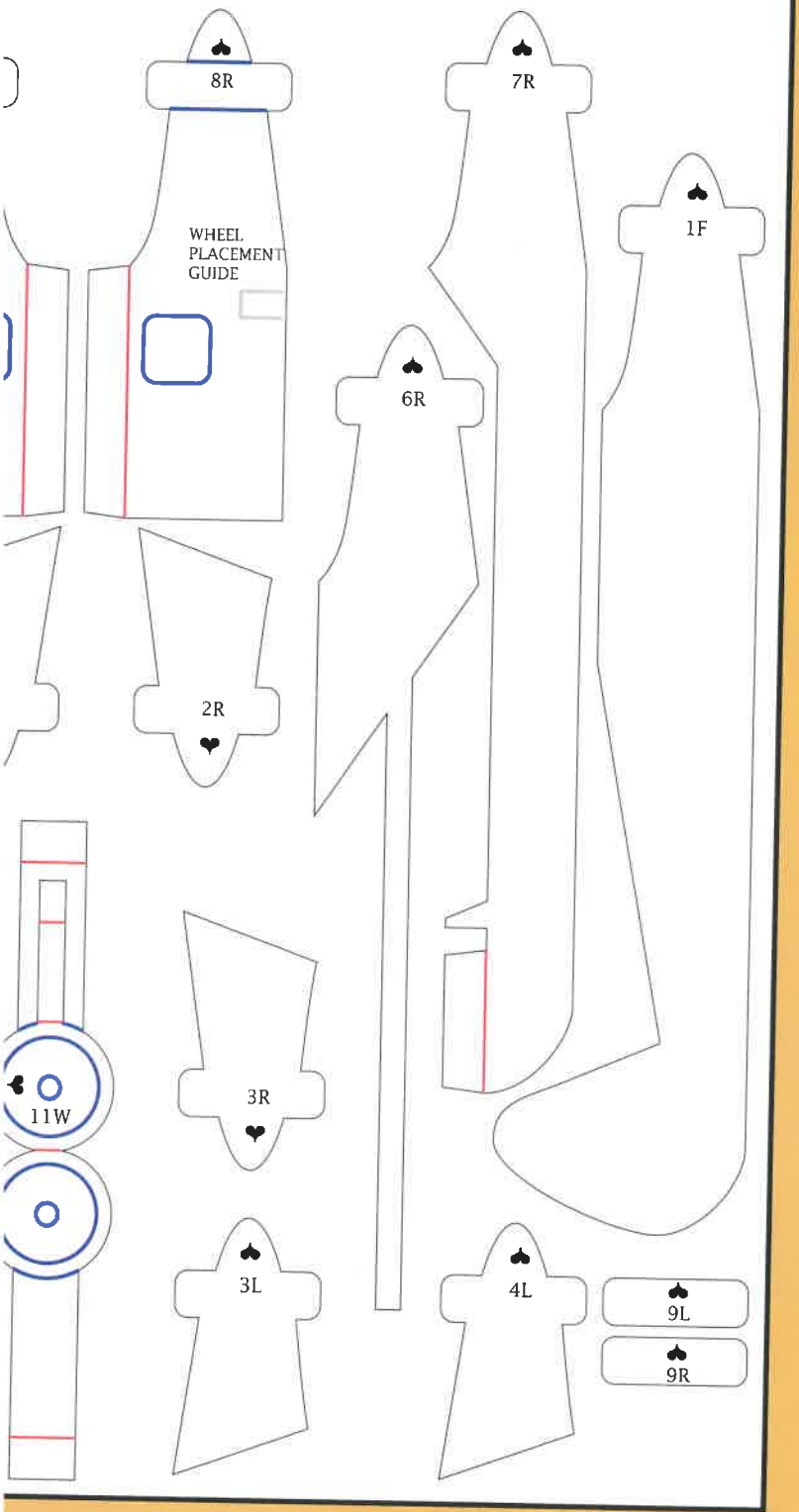
camber:
point of maxim
20-30% from fr

dihedral angle:
wings 3°

E PIECES

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



lindbergh

The pioneers of aviation knew that their machines were extremely fragile, under-powered, and of limited use. To encourage the development of airplanes, prizes were offered by wealthy corporations for various aerial feats. This hastened their improvement, but after the war of 1914-18 aviation fell into a slump and prizes and sponsorships were continued as the main incentive to support the industry. In 1913 the Daily Mail newspaper of London announced a £10,000 prize for non-stop flight across the Atlantic ocean. This offer still stood after the war ended, and was achieved only in 1919 when John Alcock and Arthur Brown flew a Vickers Vimy from Newfoundland to Ireland in 16 hours 27 minutes. Some 92 successful trans-Atlantic flights were made, but all were done with multiple crews flying multiengined machines. To encourage a solo crossing a $25,000 prize was offered.

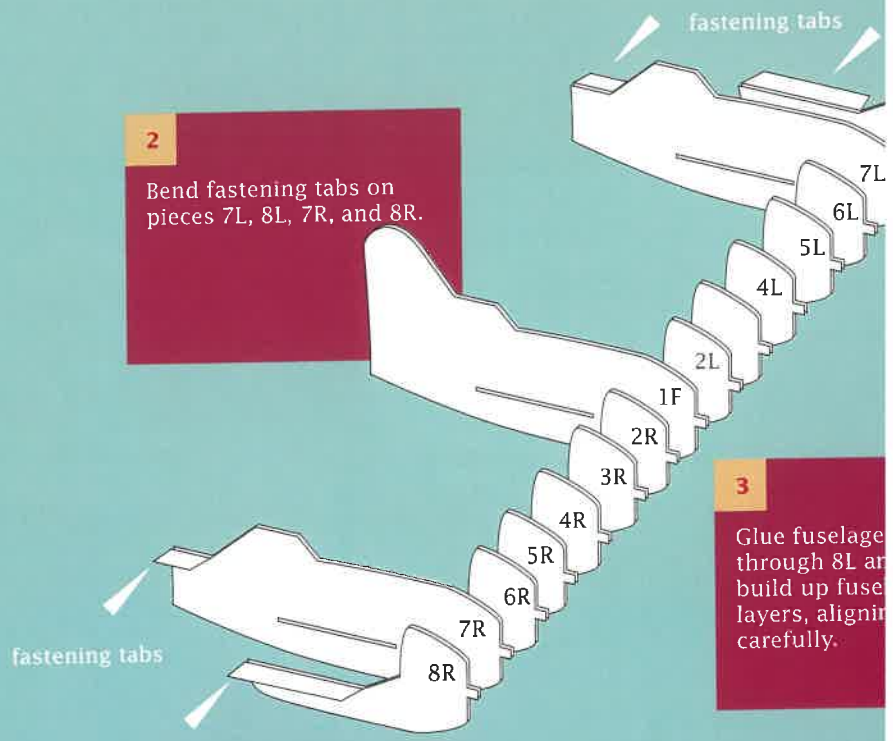
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 7L, 8L, 7R, and 8R.

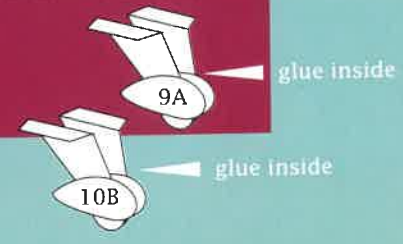


3

Glue fuselage through 8L ar build up fuse layers, alignir carefully.

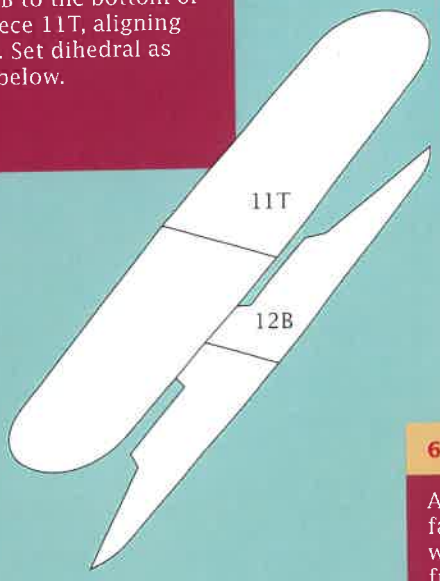
4

Glue the two wheel assemblies 9A and 10B.



5

Glue 12B to the bottom of wing piece 11T, aligning centers. Set dihedral as shown below.



6

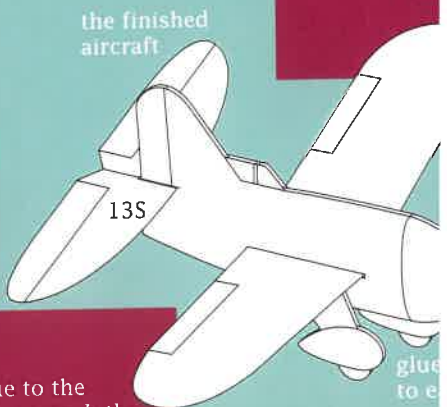
Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines.

7

Applying glue to the fastening tabs, attach the stabilizer 13S to the fuselage. Then glue one wheel to each side of the aircraft, as shown. Use wheel placement guides (pp62-63).

8

Camber the w curving the p between thur forefinger. Se



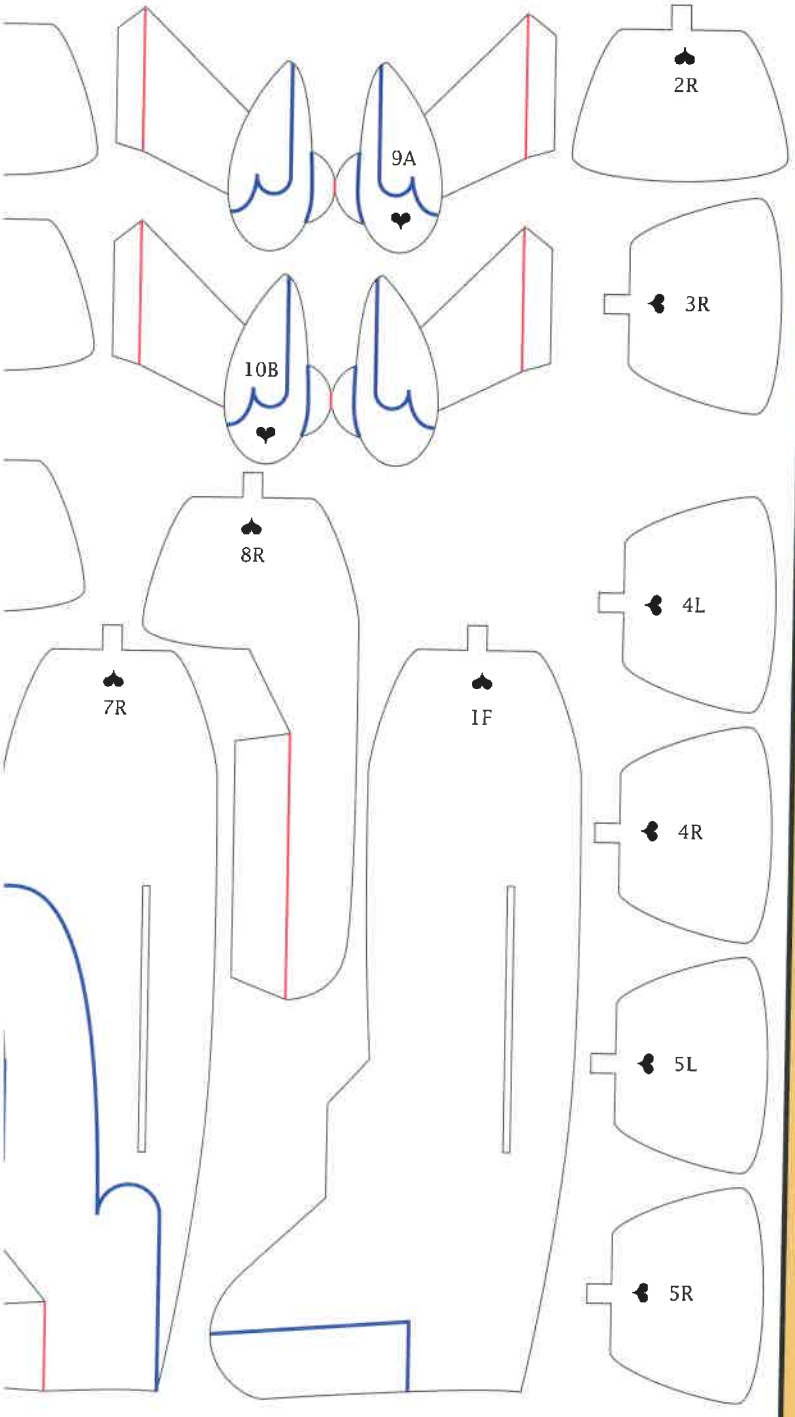
camber:
point of maxim
20-30% from fr

E PIECES

gee bee

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



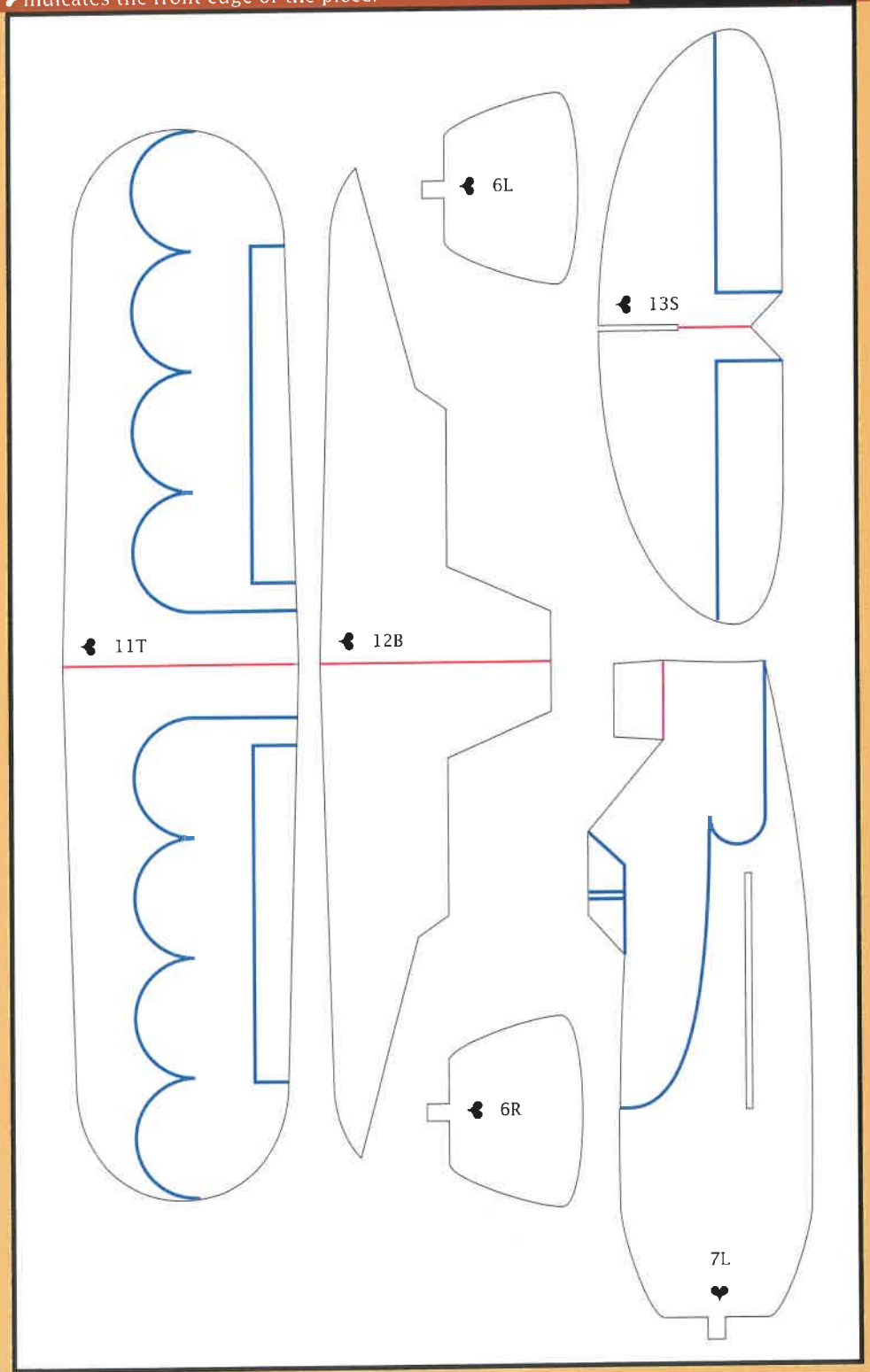
The success of Lindbergh's flight spawned a variety of public aerial events worldwide. The public could not get enough of the excitement that flight provided. Among the events were two famous annual races in the United States. The Thompson Trophy Race was a closed-circuit round-the-pylon race and the Bendix Trophy Race was a long-distance cross-country race. Such events kept aviation in the forefront of public attention at a time when the commercial use of airplanes was not yet widely established.

In 1932 Granville Bros. Aircraft was formed by members of the Granville family and a few hired hands. Their goal was to build an airplane that would go fast. The elder brother Zantford, known as "Granny," was an intuitive engineer. He conceived of an airframe that could fly both pylon and long-distance races utilizing a different engine for each. This was the Gee Bee Model R.

GEE BEE PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- ❥ Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



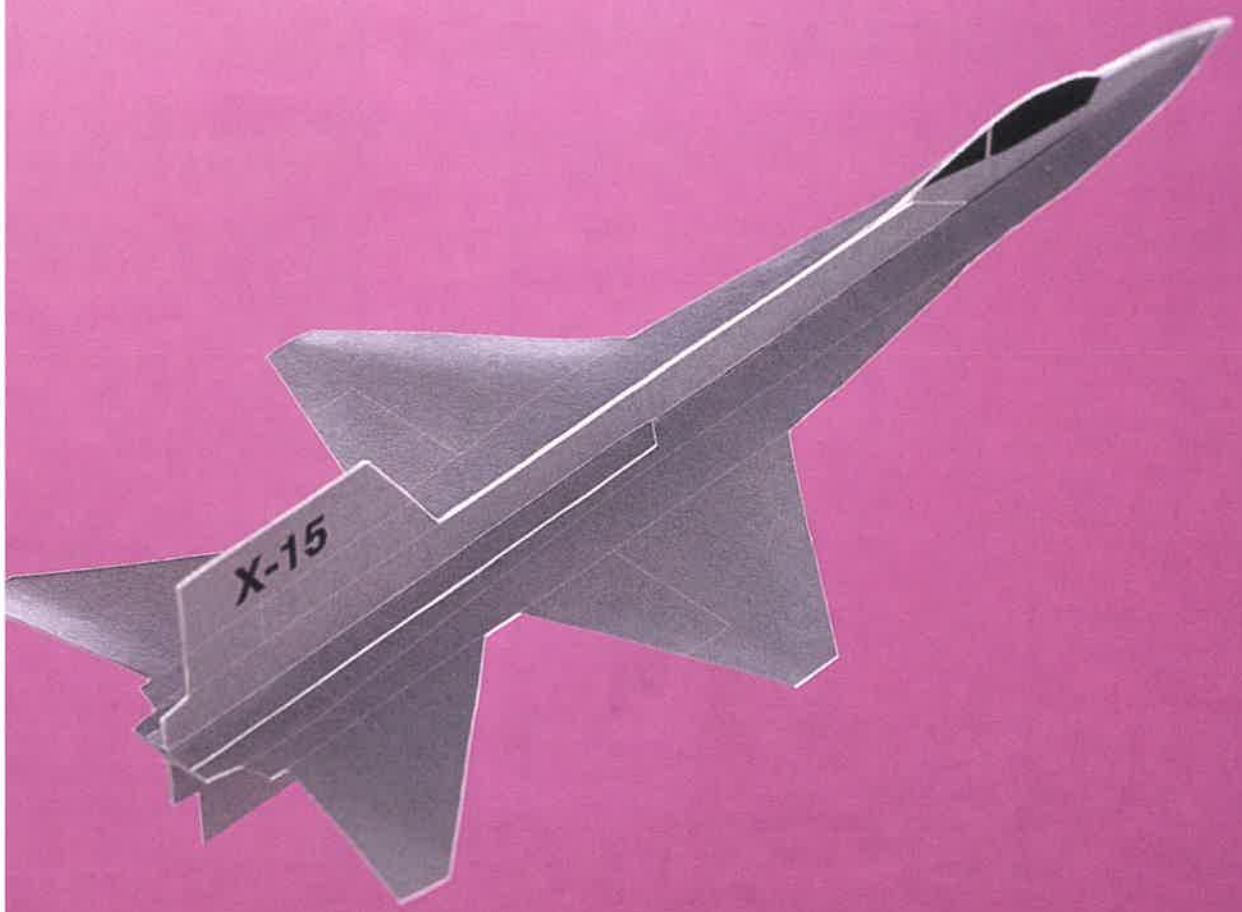
The R model was, in fa
engine. The Granvilles
tested the smallest pos
airframe for the largest
engine. This small airp
something like a barrel
stubby wings.

In 1932 this plane, pow
800 hp Pratt and Whitn
engine, won the Thomp
at a speed of 252 mph.
Bee Model R has becom
legend, not for what it
but for an impression l
public mind that it was
ous beast. Thousands
not only the successful
this incredible machine
two spectacular crashe
which was forever capt
film.

Although somewhat ur
airplane was a great m
successful racer. Today
has been built by Delm
and is flown at many a
the delight of large cro

flying model

NORTH AMERICAN X-15 spaceplane



LE ACHIEVEMENTS

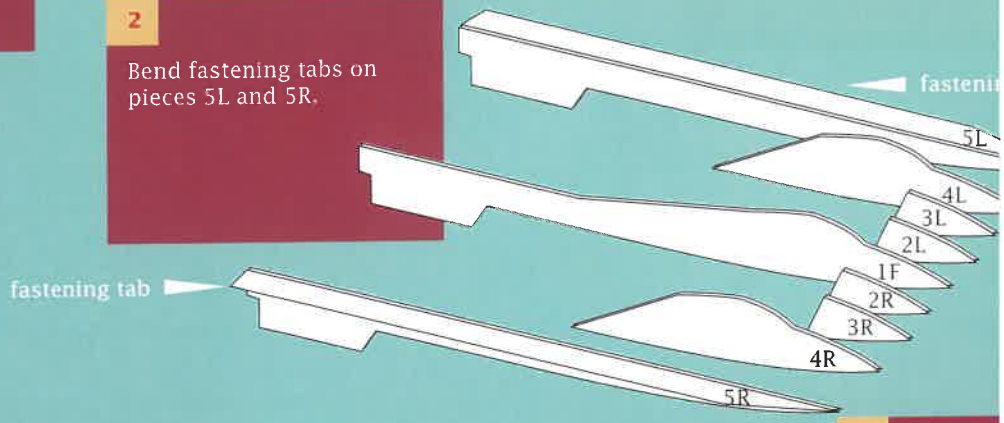
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 5L and 5R.

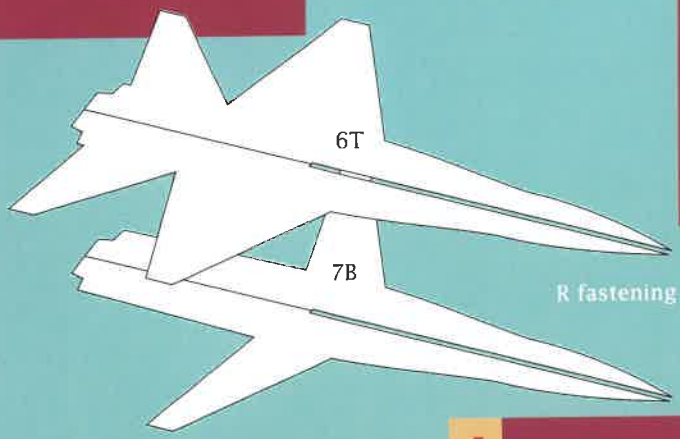


3

Glue fuselage through 5L a build up fuse layers, aligni carefully.

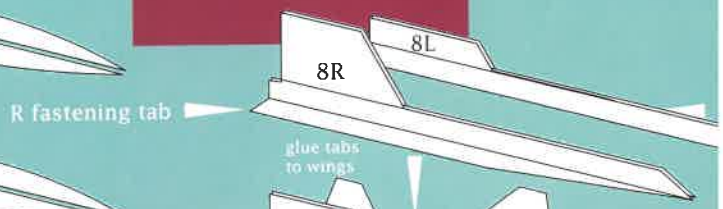
4

Glue 7B to the bottom of wing piece 6T, aligning centers. Set dihedral as shown below.



7

To complete the aircraft, make the rudder section of the fuselage. At the same time, glue 8L to 8R, the L and R fastening tabs to the wings, and its front to the left and the right of the cockpit section. Align along center line.

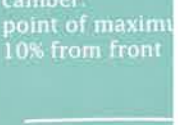


5

Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines.

6

Camber the wings by curving the paper gently between thumb and forefinger. See right.

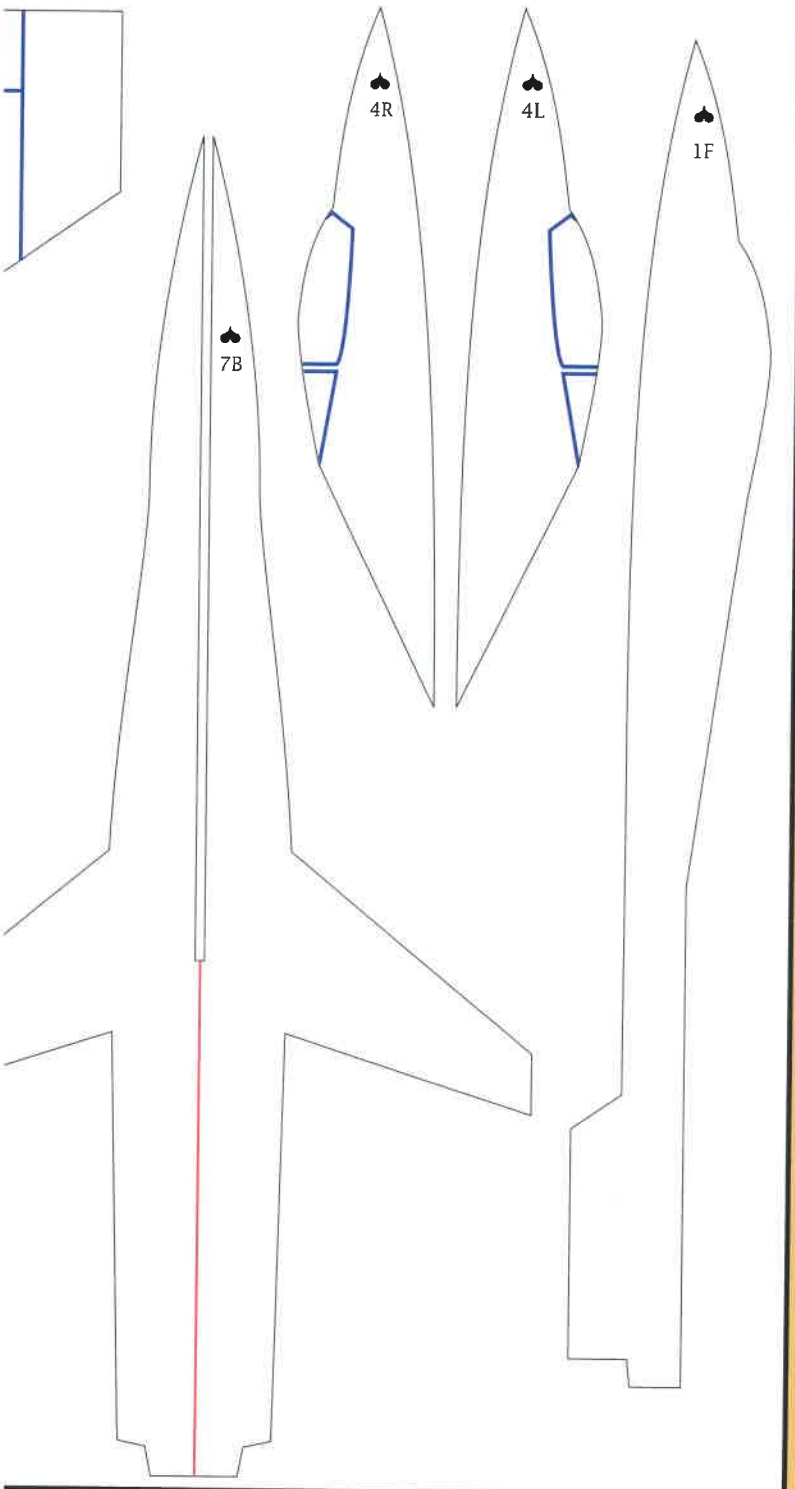


E PIECES

X-15

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



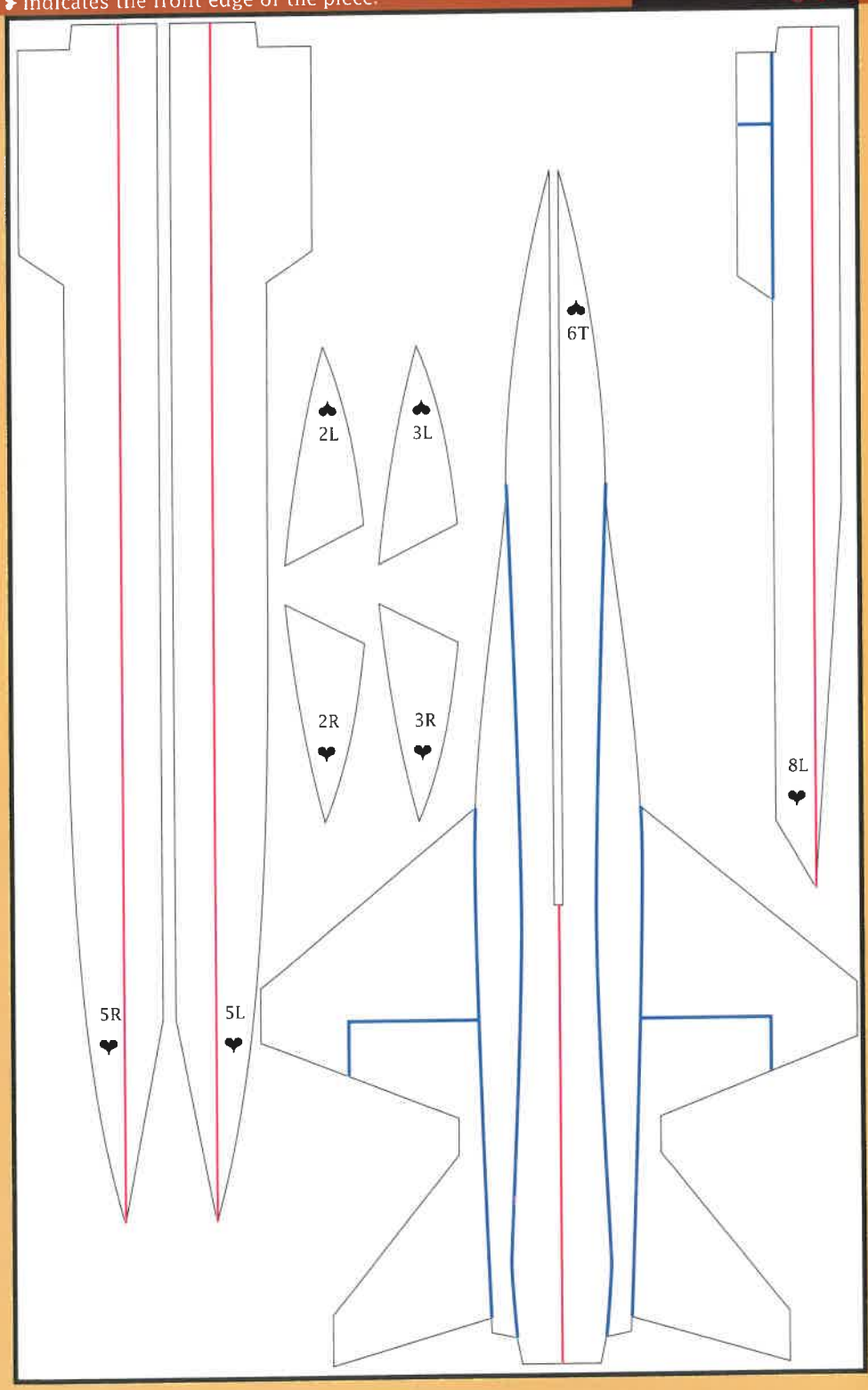
It was thought at one time that the best way to leave the earth's atmosphere would be to fly an airplane high enough and fast enough to go into low earth orbit. Consequently a call for an experimental airplane that could fly to the edge of the atmosphere came from the National Advisory Committee for Aeronautics (now National Aeronautics and Space Administration) as early as 1950, three years after the X-1 had first broken the sound barrier, which is a speed of about 740 mph called Mach 1. A hypersonic study team was brought together, who by 1954, had developed the primary concept for such an aircraft.

Hypersonic meant speeds of between Mach 5 and 7. Three things were evident: that the aircraft be powered by rocket engine, since no jets were thought to be powerful enough for the task; that new materials were needed to withstand the stresses; and that it be "piggy-back" launched to avoid the problems of ground takeoff (mainly the need for a large quantity of fuel).

X-15 PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



The X-15 was the resul
the North American Co
using super-alloys for
special coatings made
catalyst, and glass bea
protect it from the ext
caused by air friction.
feet long with a 22 foo
and 11 foot tail. It was
one throttleable YLR-9
engine that burned a n
anhydrous ammonia a
oxygen with a 2 minut
and 57,000 pounds of
addition to this it had
tion thrusters to steer
subspace altitudes wh
was not enough air for
and tail to be operatio

Although the idea of fl
space with an airplane
dropped in exchange f
off in the mid-60s, the
vided much useful inf
about transatmospher
achieved Mach 6.7 at
(106,260 m). The pilot
for astronaut's wings b
were any orbital flight

flying model

McDONNELL DOUGLAS F-4 Phantom II

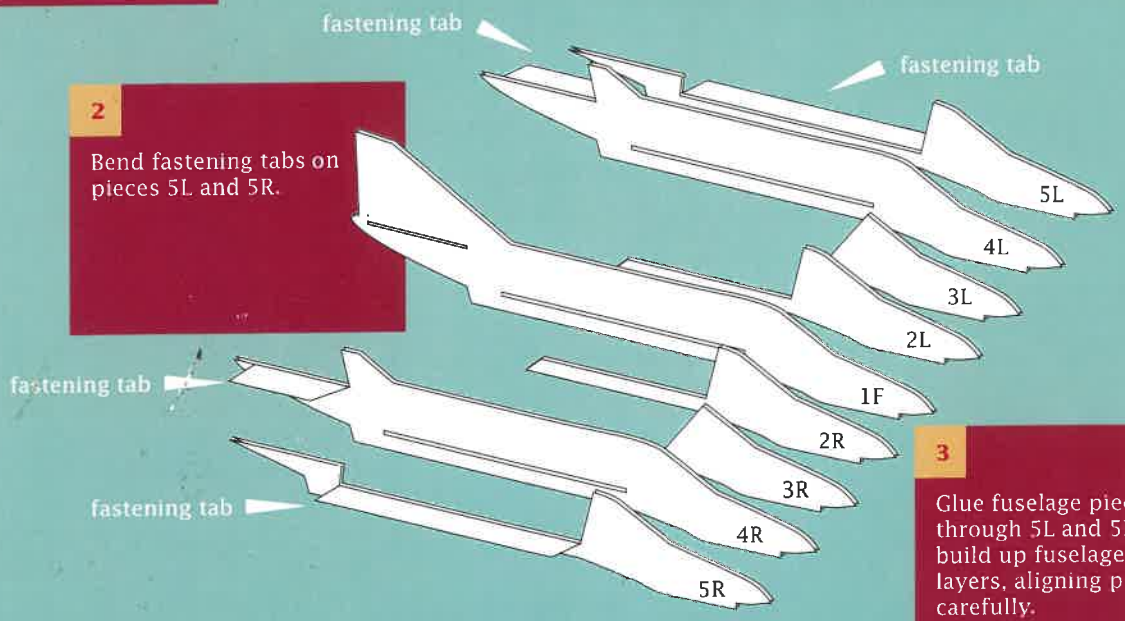
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 5L and 5R.

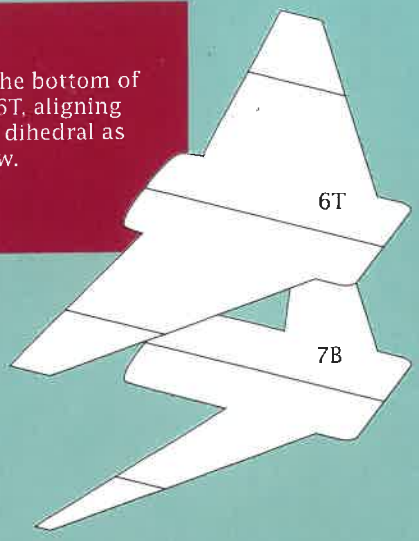


3

Glue fuselage piece 1F through 5L and 5R to build up fuselage layers, aligning pieces carefully.

4

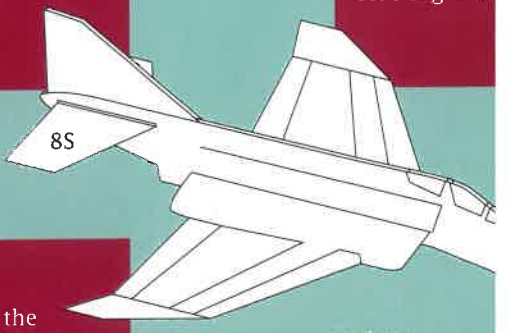
Glue 7B to the bottom of wing piece 6T, aligning centers. Set dihedral as shown below.



dihedral angle:
wings 0°
wingtips 30°
hor stab minus 1°

5

Applying glue to the fastening tabs, attach the stabilizer 8S to the fuselage.



6

Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines.

7

Camber the w
curving the p
between thu
forefinger. Se

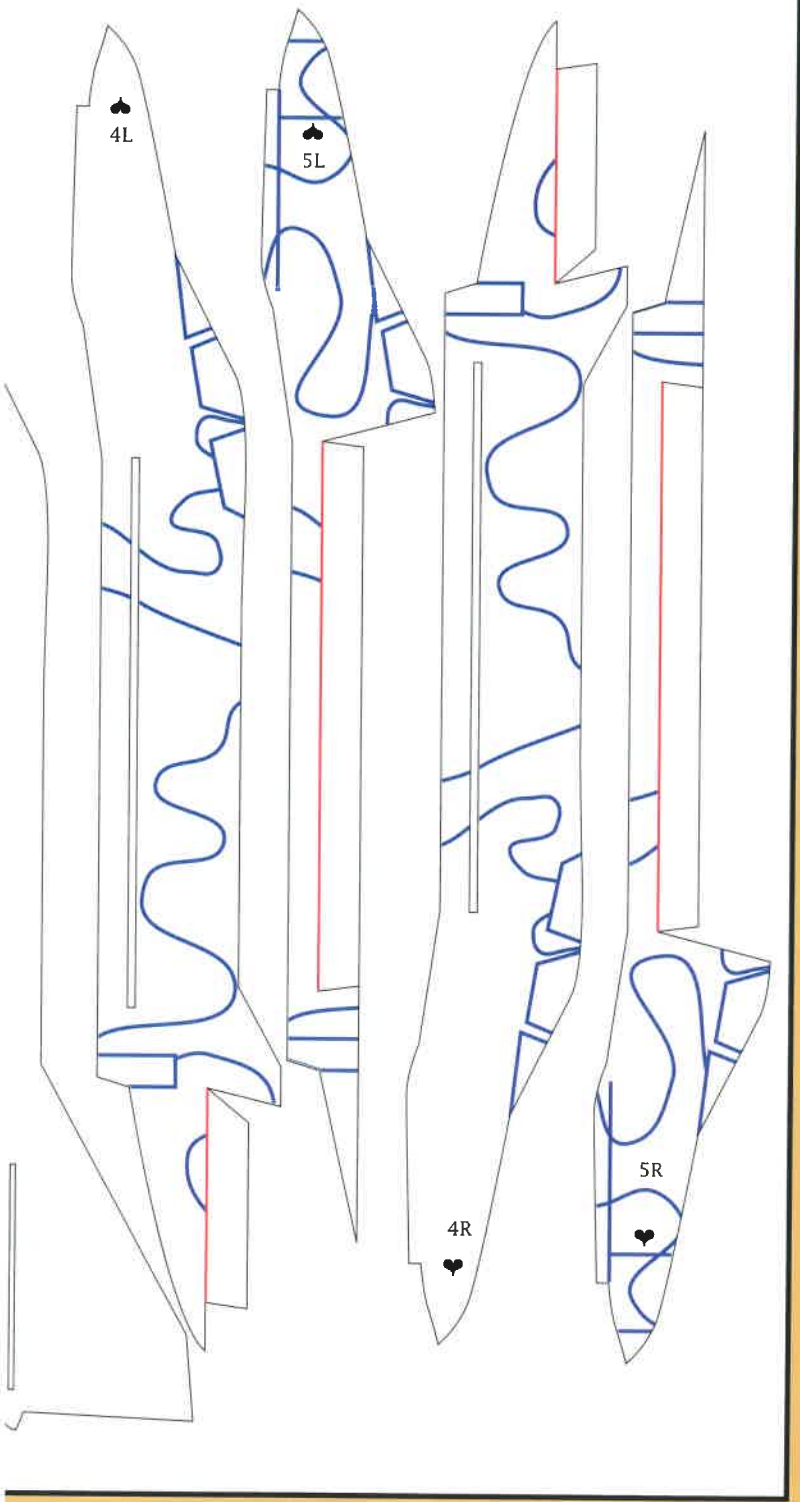
camber:
point of maximu
5-10% from fron

E PIECES

F-4

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



This airplane, built by McDonnell Douglas, is one of the most numerous fighters to be built after the Second World War. It was in production from 1959 through 1979, with more than 5000 being built in the United States and Japan. Incredibly it remains in service with at least ten countries and will continue service well into the 21st century, giving it the longest service life of any fighter.

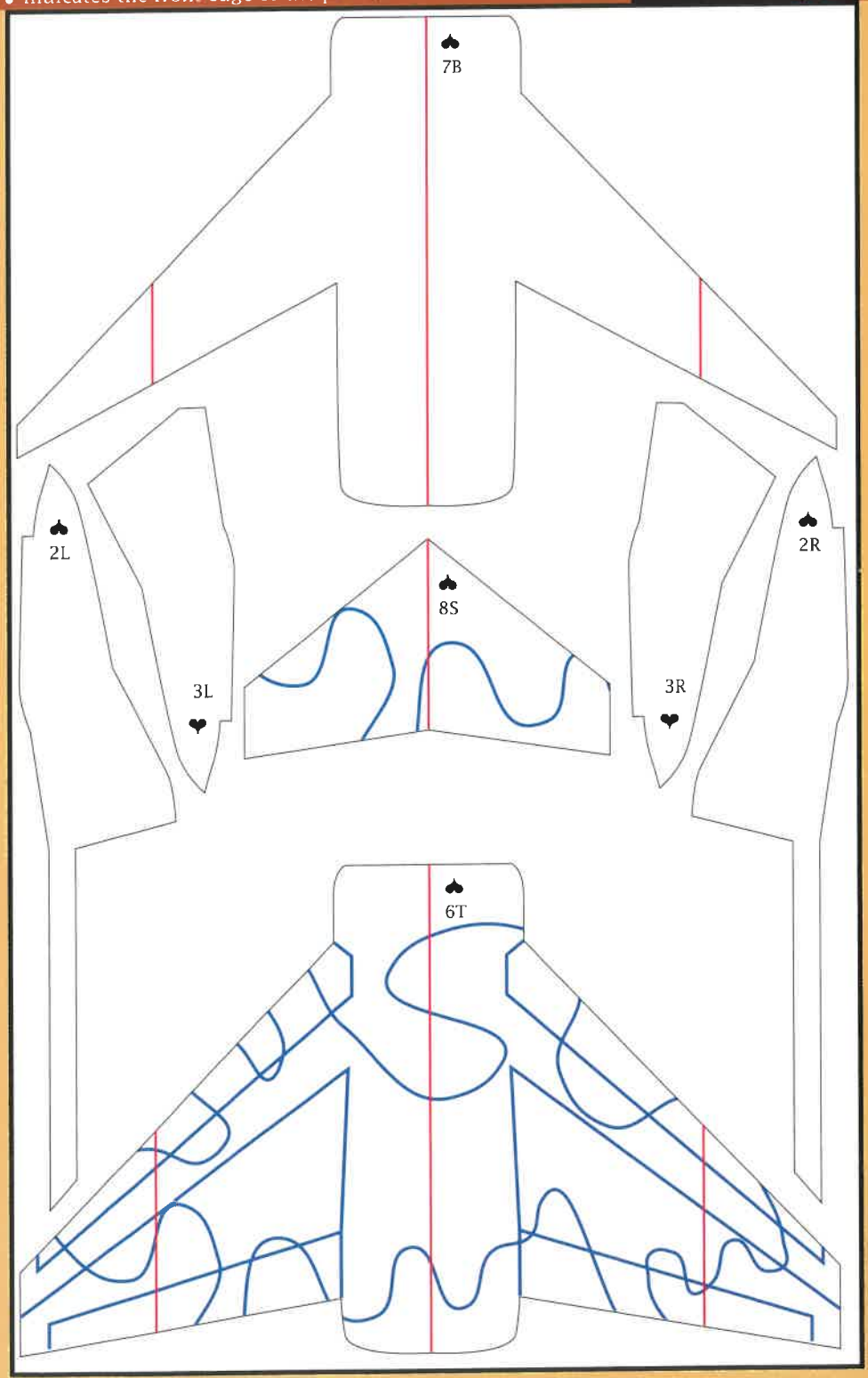
It was assumed that fighter planes would no longer need to be armed with guns after the advent of supersonic flight with jet propulsion and air-to-air rockets. The Phantom was therefore the first to be built without gun armament. It was soon discovered, however, that this was a false assumption, and provisions were made to add a gun pod underneath.

In fact, this airplane, designed to be either land or carrier based, boasts many firsts, one of which

F-4 PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- ♠ Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY

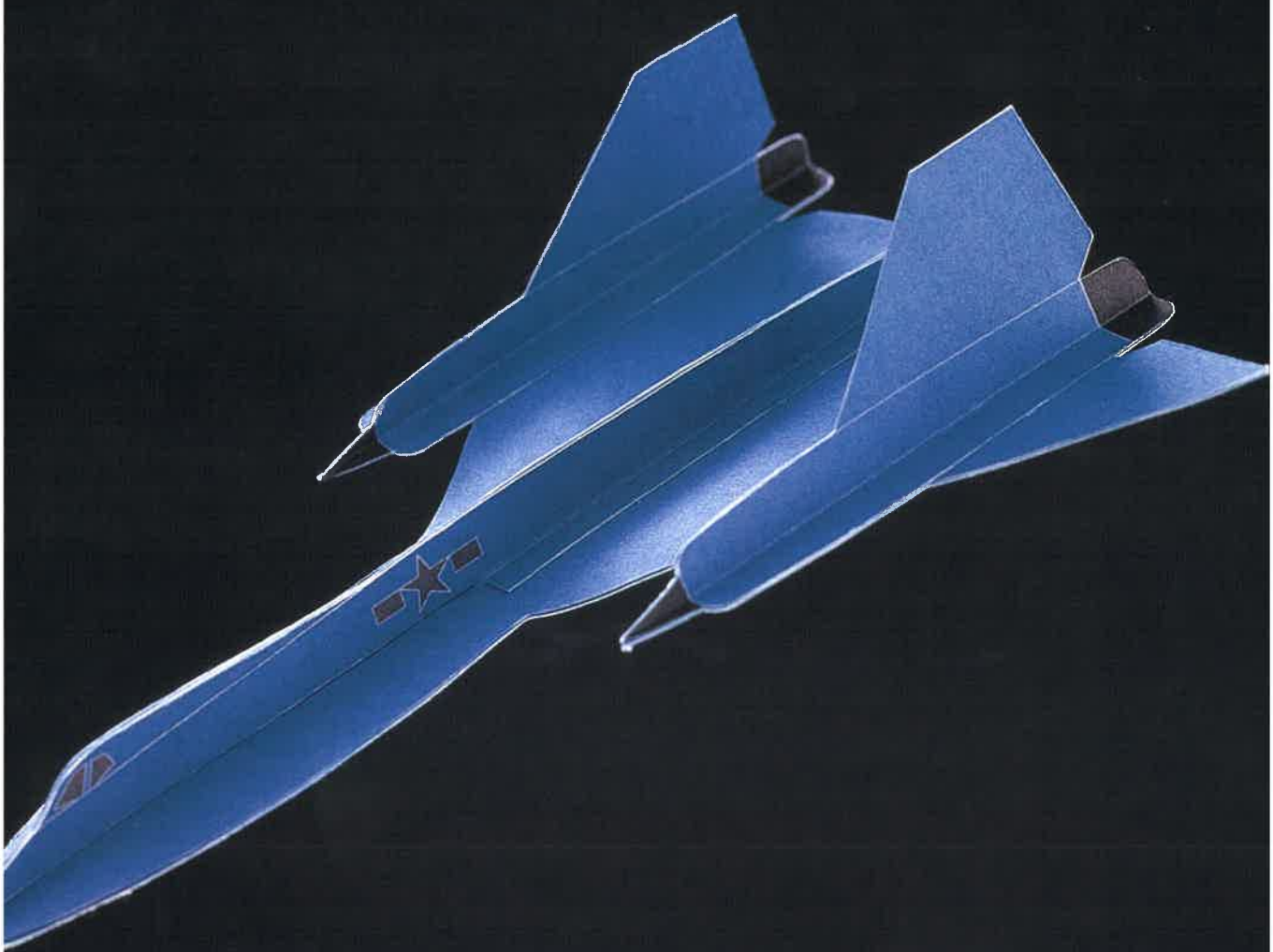


was the ability to hang
variety of armaments
airframe hardpoints. T
into a very versatile m
is one of the keys to it
was also the first fight
electronics to manage
systems to optimize p
as well as to search fo
and destroy targets th
beyond visual range, w
support from ground
twin-engine afterburni
flies at Mach 2 and has
altitude of 40,000 feet

Over the years some 3
the Phantom have bee
the 1960s this airplane
pride of the aeronauti
ment and demonstrate
of aeronautical achiev
consequence it was flo
shows by the display t
US Navy Blue Angels a
Force Thunderbirds si
ously.

flying model

LOCKHEED SR-71 blackbird



LE ACHIEVEMENTS

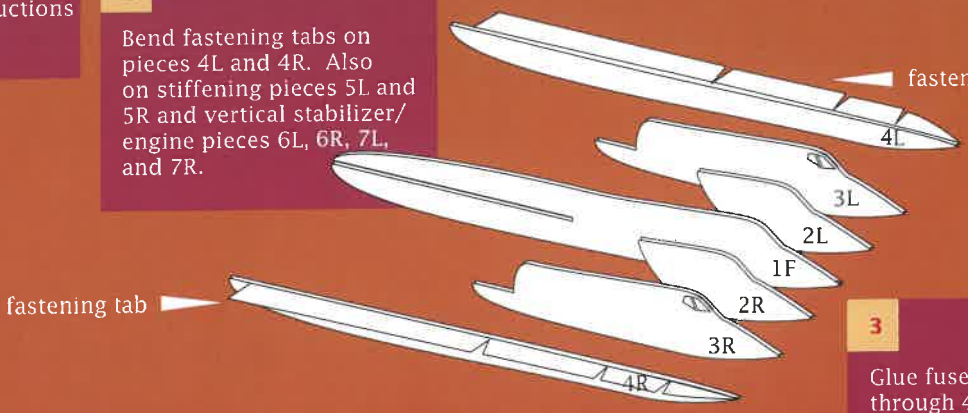
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on pieces 4L and 4R. Also on stiffening pieces 5L and 5R and vertical stabilizer/ engine pieces 6L, 6R, 7L, and 7R.



3

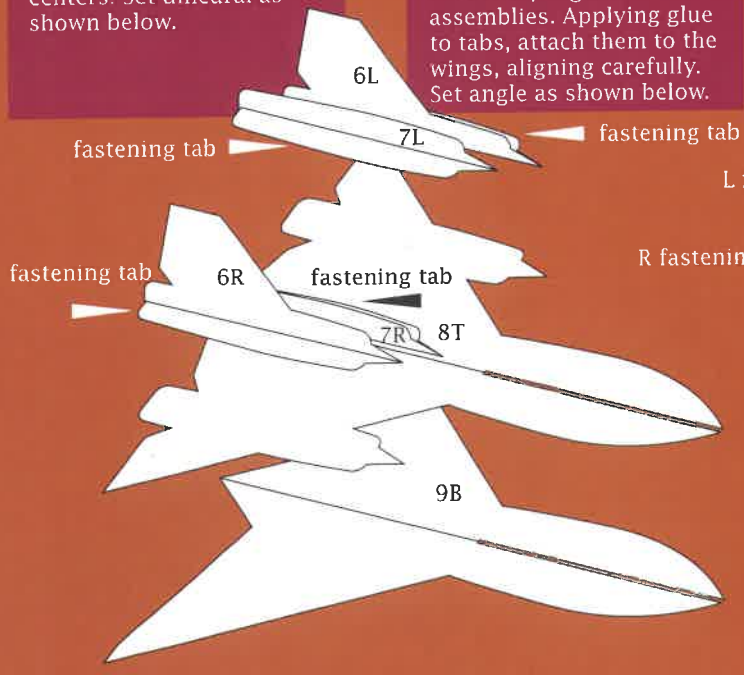
Glue fuselage pie through 4L and 4 build up fuselage layers, aligning p carefully.

4

Glue 9B to the bottom of wing piece 8T, aligning centers. Set dihedral as shown below.

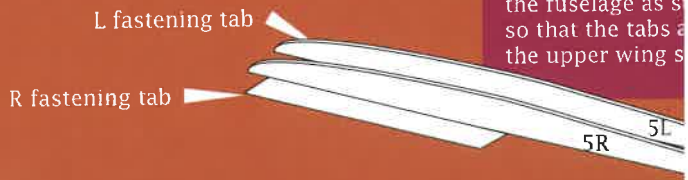
5

Glue piece 7L to 6L and 7R to 6R to make the vertical stabilizer/engine assemblies. Applying glue to tabs, attach them to the wings, aligning carefully. Set angle as shown below.



7

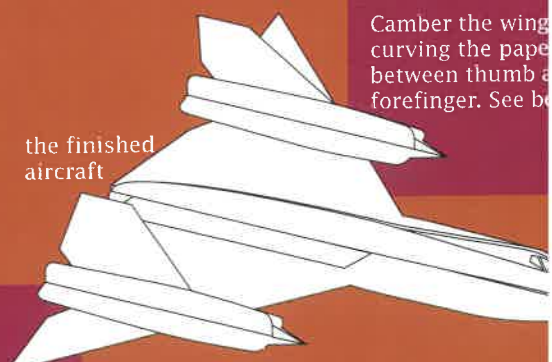
Applying glue to and 5R, attach th left and right har the fuselage as s so that the tabs a the upper wing s



8

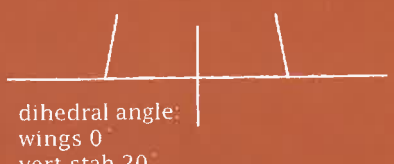
Camber the wing curving the pape between thumb a forefinger. See b

the finished aircraft



6

Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines.



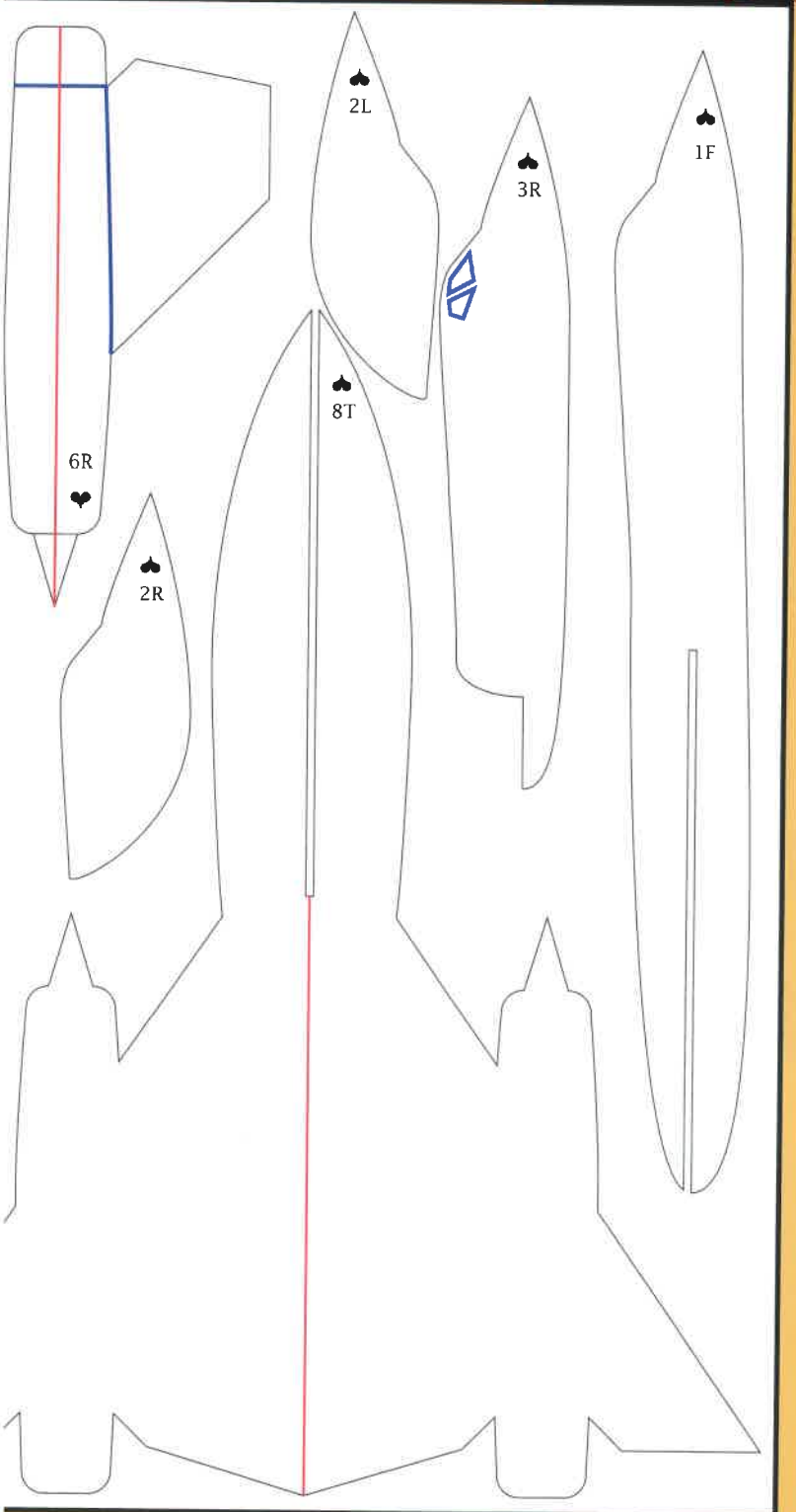
camber:
point of maximu
5-10% from fron

E PIECES

SR-71

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



The SR-71 was designed for one purpose only: to take pictures while flying high and fast. In fact, it flew so high and fast that no enemy armaments of any kind could touch it. It was a global strategic reconnaissance spy plane.

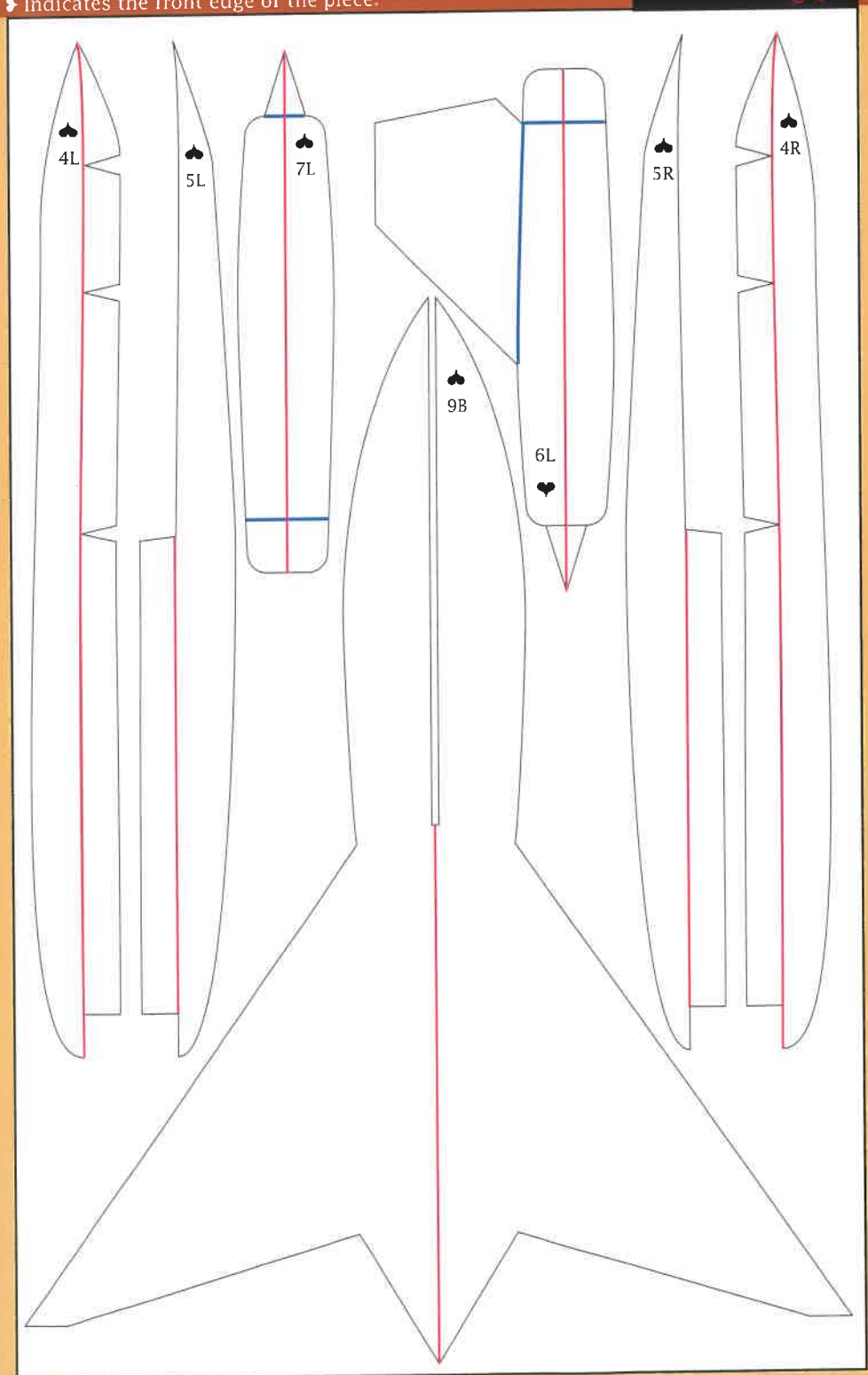
The incredible pictures taken by this airplane are so sharp that they reveal objects as small as a golfball from an altitude of 80,000 feet (24,000 m). In each hour of flight more than 100,000 square miles (260,000 sq km) of the earth's surface are photographed.

When this airplane was being developed in the late 1950s-early 60s, no technology existed to accomplish the task of building components that could withstand the stresses of such flight. It was under the leadership of Kelly Johnson, legendary designer with Lockheed, that the work was accomplished. The airframe is built primarily of very strong and lightweight titanium as well as compos-

SR-71 PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



ite plastics. Because of
temperature changes t
aircraft would be subje
special expansion join
needed to allow for ch
size of components. In
skin of the plane heats
degrees F (427 ° C) fron
and the entire airframe
in length by six inches

The SR-71 is powered
and Whitney axial-flow
with special afterburn
a maximum cruise spe
Mach 3, produce most
power. This incredible
fastest and highest fly
breathing machine, se
absolute speed record
mph at a record-settin
85,068 feet (25,520 m
enough fuel to mainta
for one hour and can b
in flight (at a slower sp
lower altitude, of cour
longer in active servic
used for flight researc

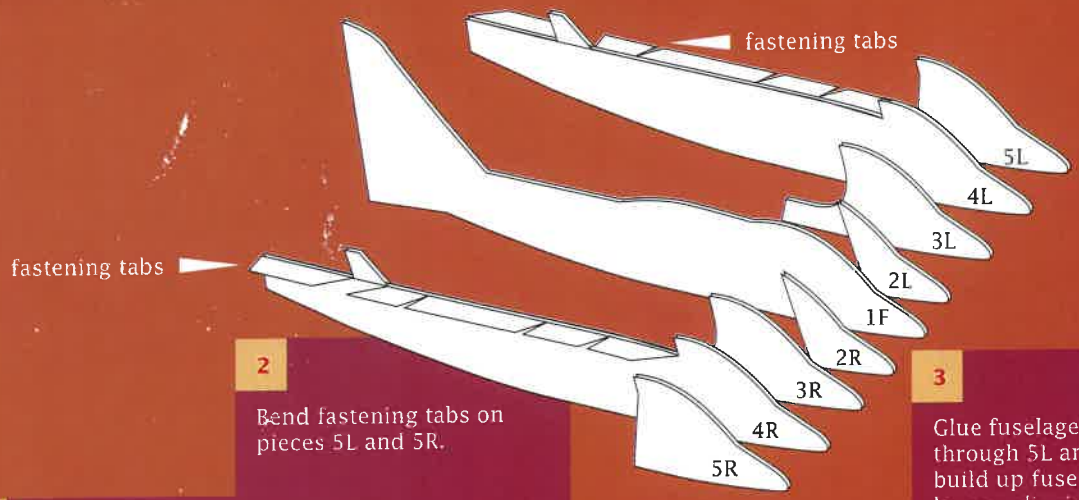
HAWKER SIDDELEY
harrier

flying model

EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)



2

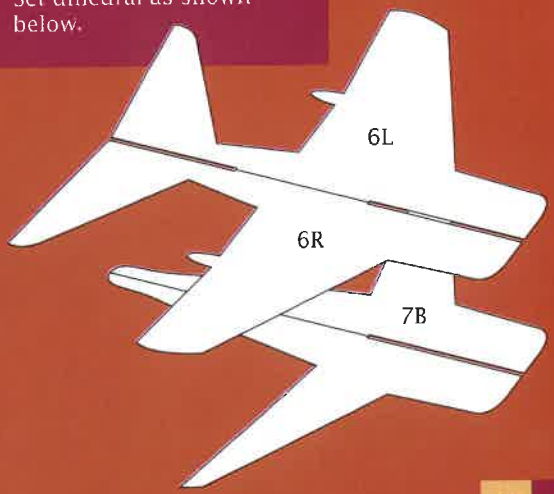
Bend fastening tabs on pieces 5L and 5R.

3

Glue fuselage piece 1F through 5L and 5R to build up fuselage layers, aligning pieces carefully.

4

Bring wing pieces 6L and 6R together, aligning carefully. Fasten by gluing 7B to the bottom, aligning centers. Set dihedral as shown below.



5

Applying glue to the fastening tabs, attach the wing assembly to the fuselage, aligning center lines.

the finished aircraft

6

Camber the wings by curving the paper gently between thumb and forefinger. See right.

dihedral angle:
wings 0
hor stab minus 12

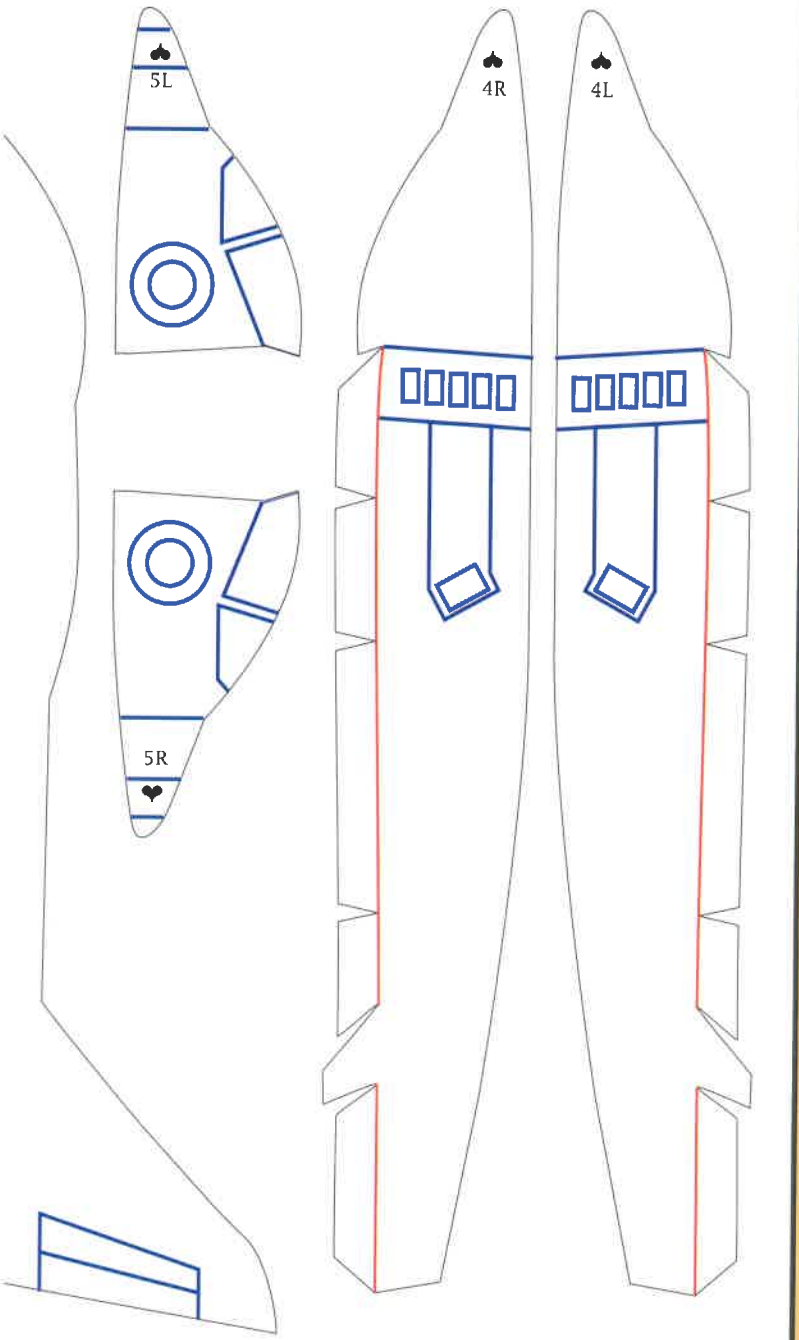
camber:
point of maximu
10% from front

E PIECES

harrier

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



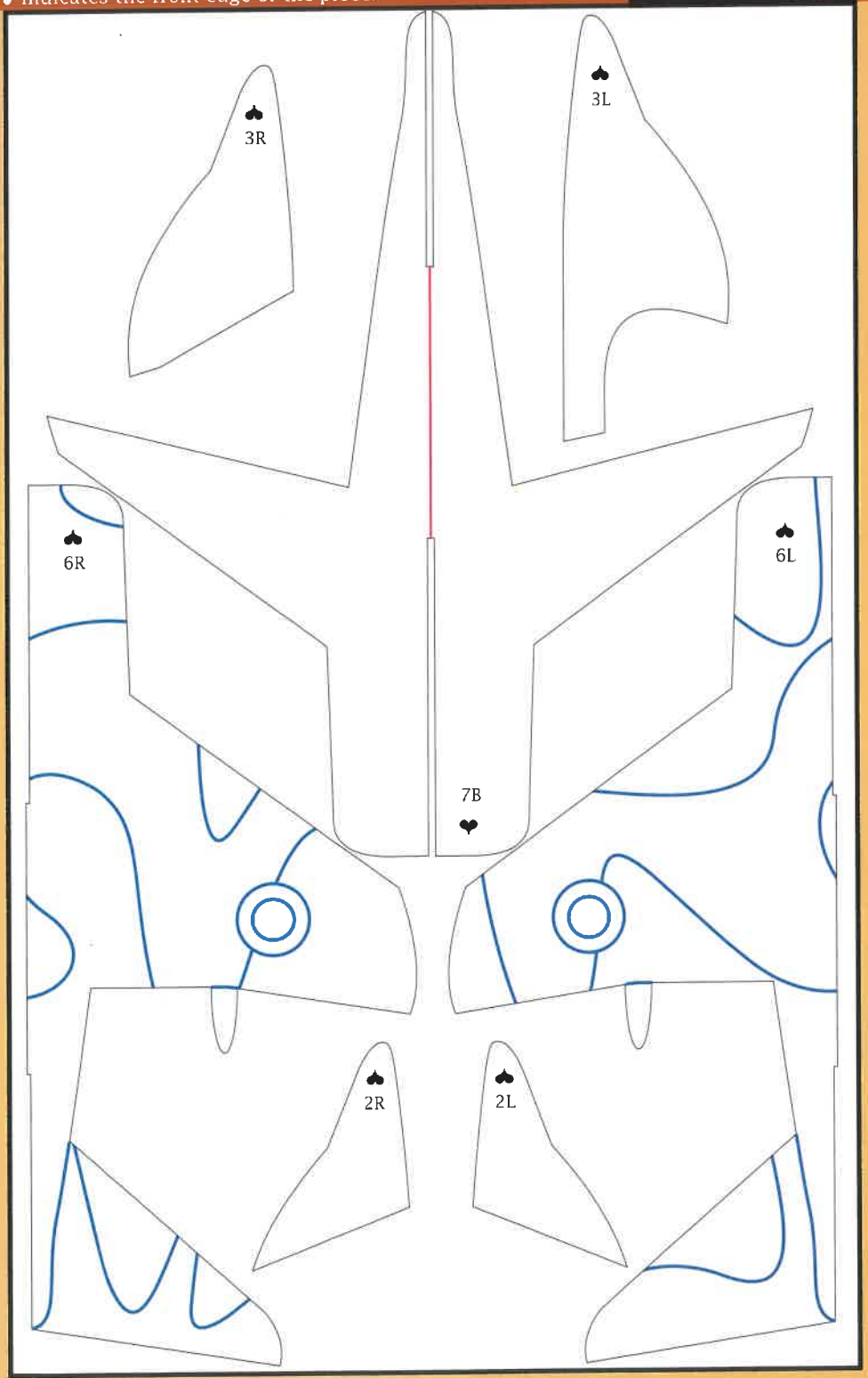
Air forces have long realized that for military purposes the need for a runway is a liability. Runways in battle are easy targets and hard to maintain. During the 1950s a variety of experimental aircraft capable of taking off vertically without the need of a runway was built. The problem was not the vertical takeoff so much as the transition to horizontal flight. In 1960 the British company Hawker Siddeley was the first to build an experimental airplane that could successfully take off vertically, hover, and transition to horizontal flight and then back to vertical landing. But it was not until 1969 that the plane was suitably safe to be made operational as a fighter. Even then, it was not an easy aircraft to pilot.

A pair of vectoring (rotatable) jet nozzles on each side of the fuselage direct the engine thrust vertically or horizontally to achieve the desired direction of flight. In addition to these, small puffer nozzles in the wingtips and tail

HARRIER PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



help maintain stability
nozzles are directed st
the plane performs jus
ordinary jet. In 1975 M
Douglas began to work
Hawker Siddeley in the
ment of an advanced v
resulting plane has co
wings to produce grea
better cruise capabiliti
fuel carrying capacity,
better all-around hand
teristics.

The biggest advantage
Harrier are that it can
to the battle lines, be h
from enemy view, and
at a moment's notice w
At sea, Harriers can op
much smaller aircraft
have simpler operatio
substantial costs. Besi
and USA, this incredib
used by the Armed Se
several countries, and
to be a versatile multi
aircraft that will remai
for a long time into th

RUTAN voyager

flying model

LE ACHIEVEMENTS

EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend pieces 1FT, 2T, 8L, and 8R, as shown.

(view from front)

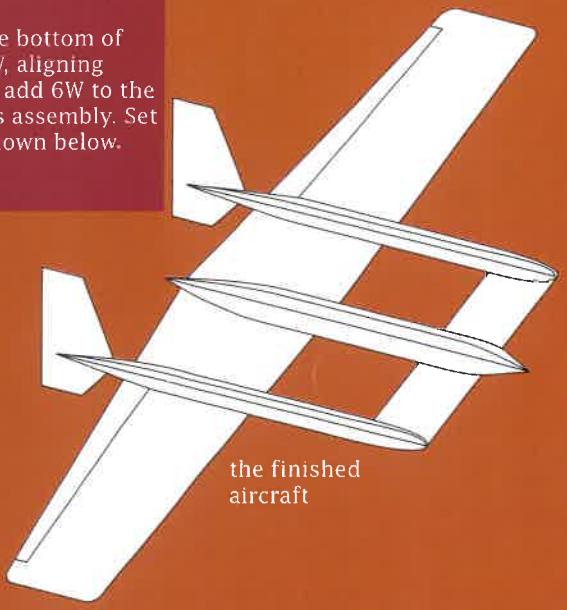
3

Bend pieces 2FB, 2B, and 3B, as shown.

(view from front)

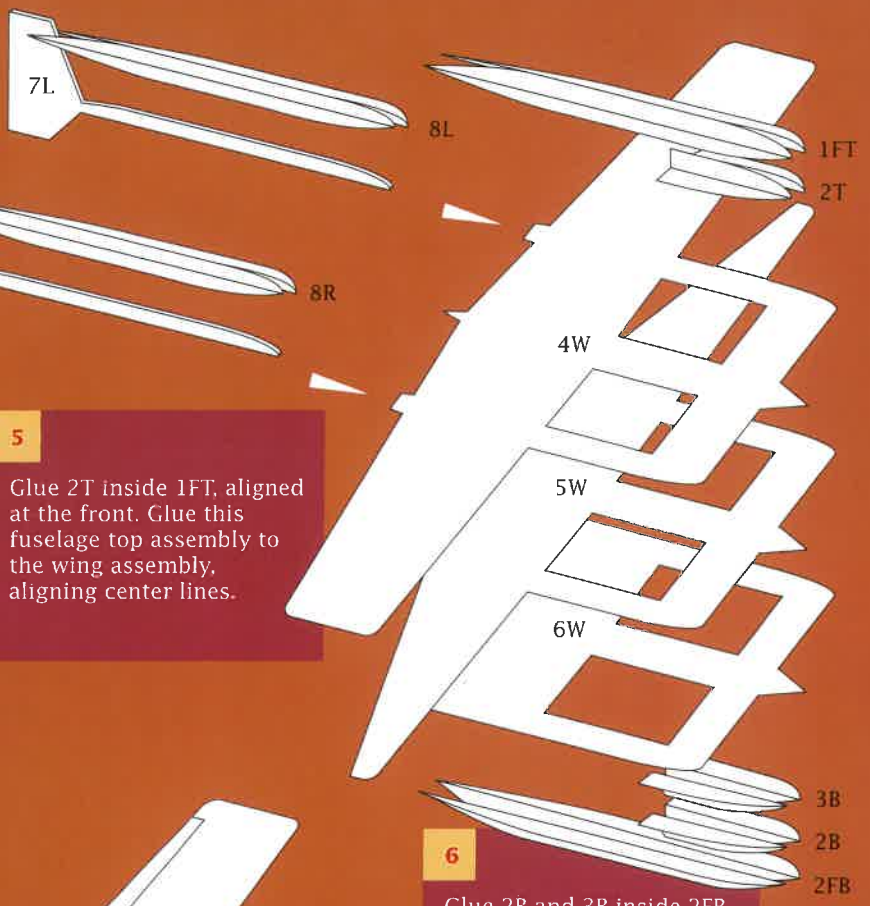
4

Glue 5W to the bottom of wing piece 4W, aligning centers. Then add 6W to the bottom of this assembly. Set dihedral as shown below.



the finished aircraft

dihedral angle:
wings 2°



5

Glue 2T inside 1FT, aligned at the front. Glue this fuselage top assembly to the wing assembly, aligning center lines.

6

Glue 2B and 3B inside 2FB, aligned at the front. Glue this fuselage bottom assembly to the wing assembly, aligning center lines.

7

Glue vertical
inside 8L and
Then glue th
stabilizer ass
wing assembl
edges.

8

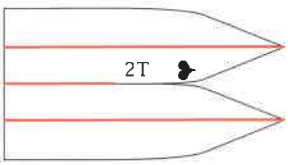
Camber the wings by curving the paper gently between thumb and forefinger. See below.

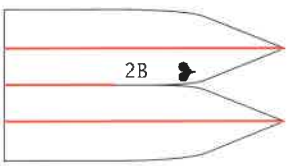
camber:
point of maximu
20-30% from fro

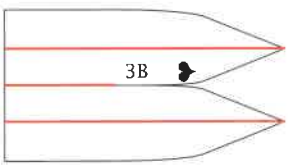
PIECES

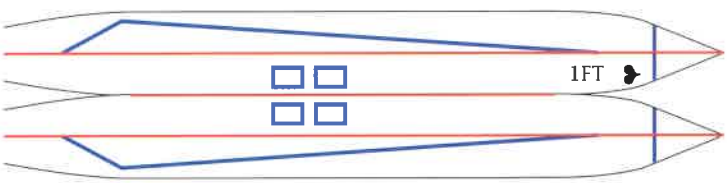
hown in black.
red.
ines as guides for adding details to the aircraft.
front edge of the piece.

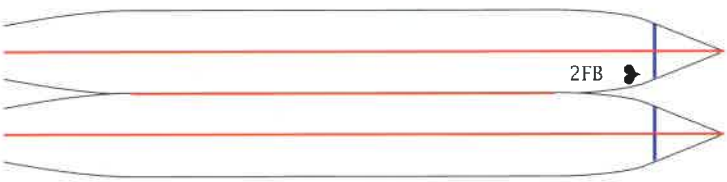
NOTE
CUT OUT PHOTOCOPY ONLY











voyager

Circumnavigating the earth began with ocean-going ships in the 15th century and took as long as 3 years. Since then ships have become faster but still require weeks for the voyage. The goal of airplanes, however, was to fly around the world in a much shorter time. The first such flight took place in 1924. The approximately 25,000 mile (40,000 km) journey was done in stages of short flights by two open cockpit biplanes, and took 175 days. This was bettered by a Graf Zeppelin airship in 1929, and was completed with only 3 refueling stops

VOYAGER PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- Indicates the front edge of the piece.

NOTE
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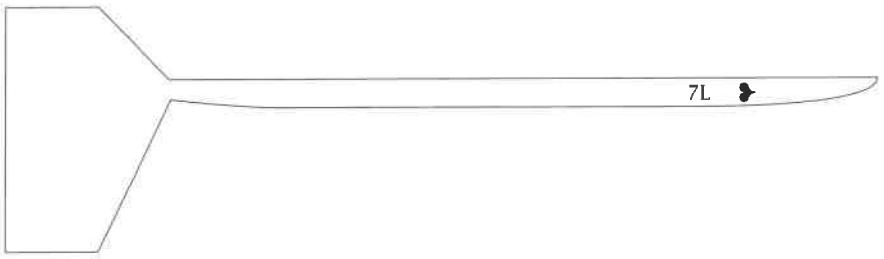
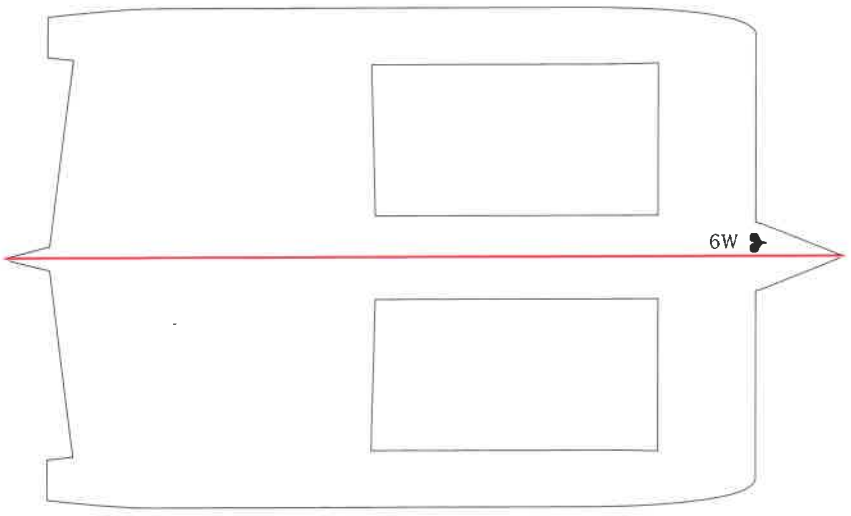


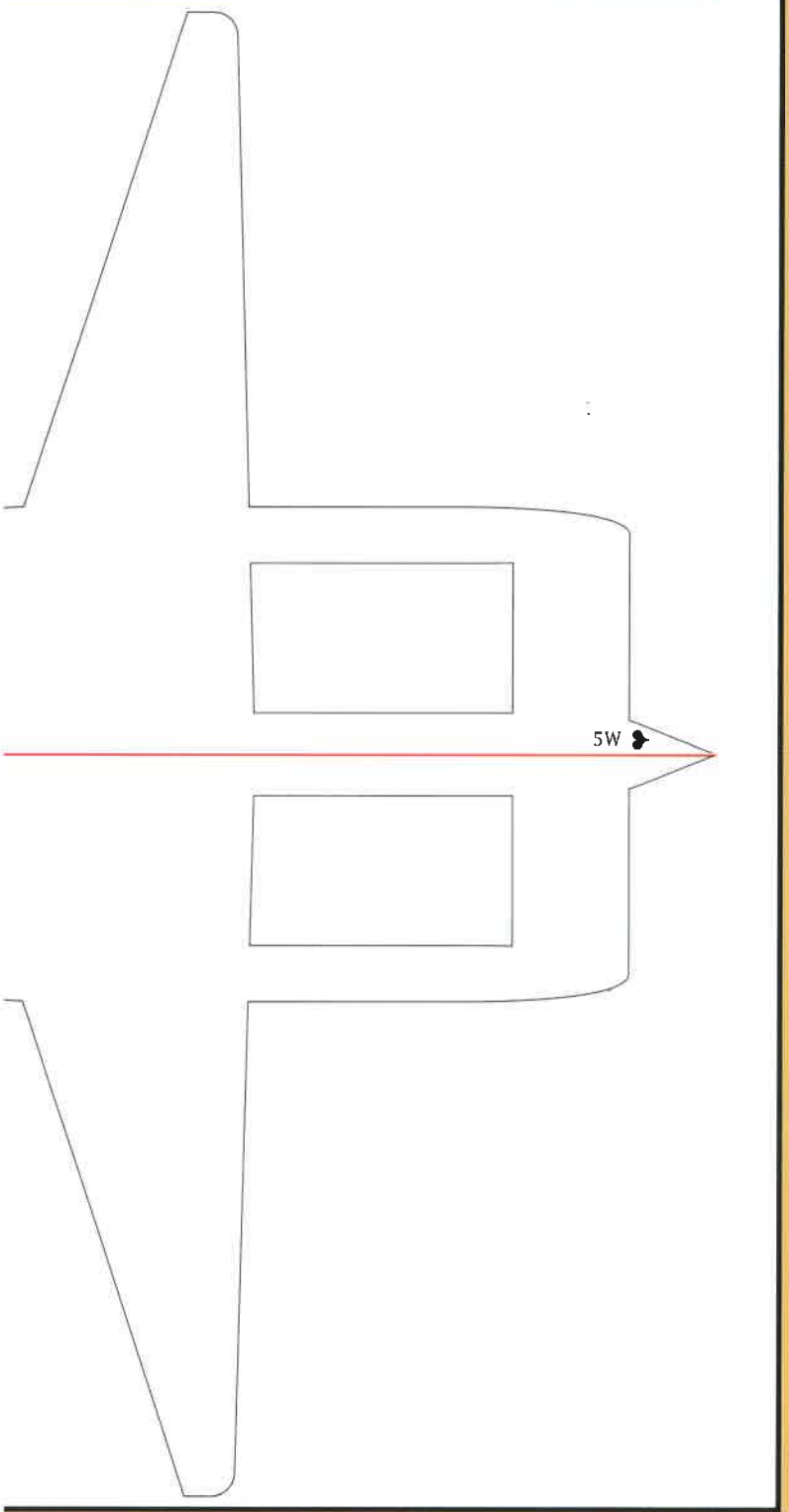


in 21 days. Encourage
Charles Lindbergh's tr
flight, Wiley Post and
Harold Gatty, in 1931,
distance in a single-er
Lockheed Vega in just
years later Post, in the
aircraft, did it solo in
first non-stop flight w
1949 by a B-52 bombe
multiple in-flight refu
last aero-circumnaviga
challenge was a non-s
refueled flight. The Vo
built especially for thi

IECES

hown in black.
red.
ines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



The people who would pilot the Voyager, Dick Rutan and Jeana Yeager, were also involved in designing, building, and testing it, over a period of 6 years. A major design challenge for such an aircraft was to match the fuel consumption to the amount carried. And fuel consumption further depended on the efficiency of the airframe and the powerplant. In the end, the plane was mainly a flying fuel tank – tanks actually. It had a total of 17, and fuel had to be shifted from tank to tank during flight to retain balance. The canard

VOYAGER PIECES

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- Indicates the front edge of the piece.

NOTE
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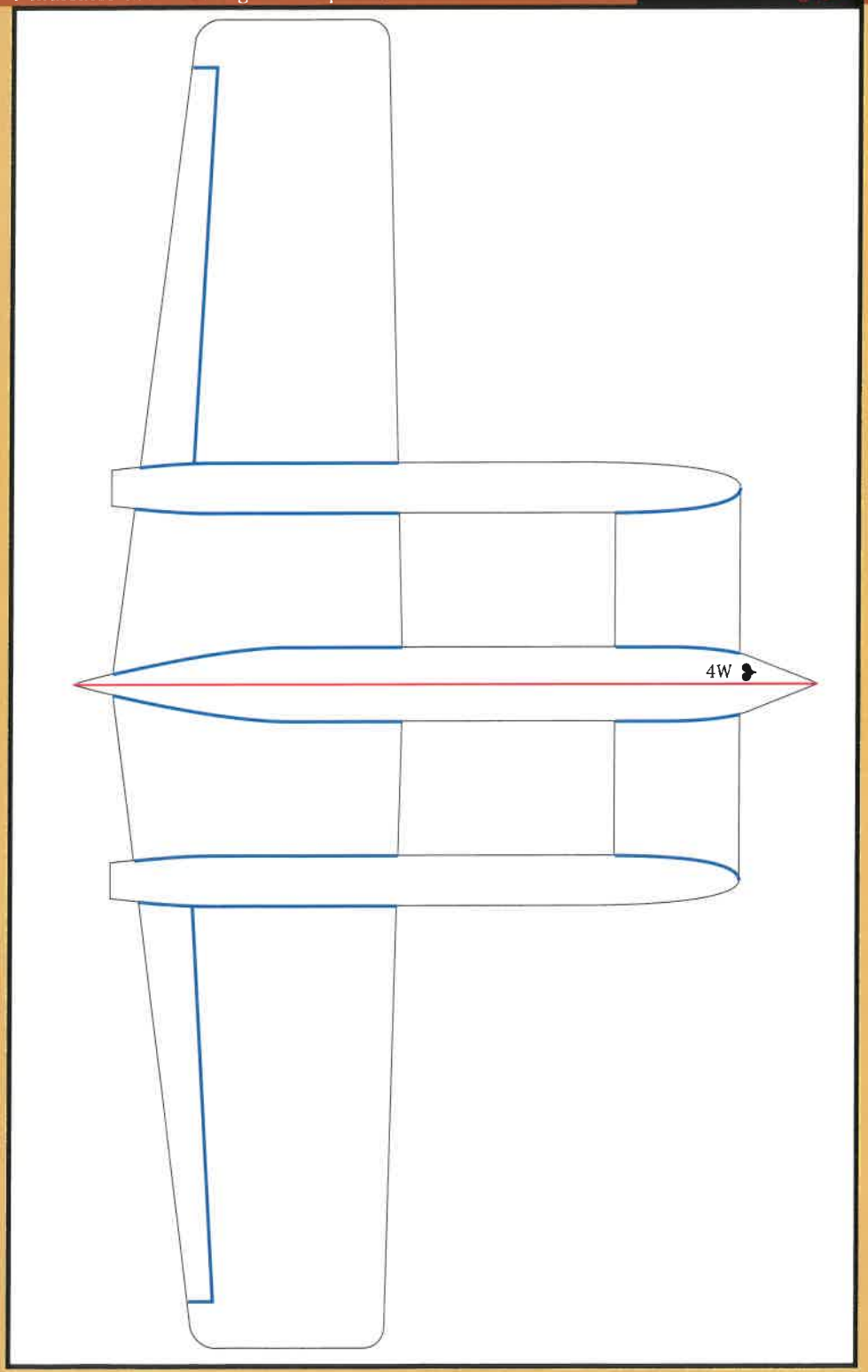


airframe was made of
composite materials w
slender wings that we
that, loaded with fuel,
rested on the ground
flexed upward 5 feet (
Propulsion came from
one at each end of the
with the front one use
ing critical times. The
pleted just before Chr
took 9 days. Incredibl
1300 gallons (5800 l)
only 11 (49 l) remaine

flying model

NASA space shuttle

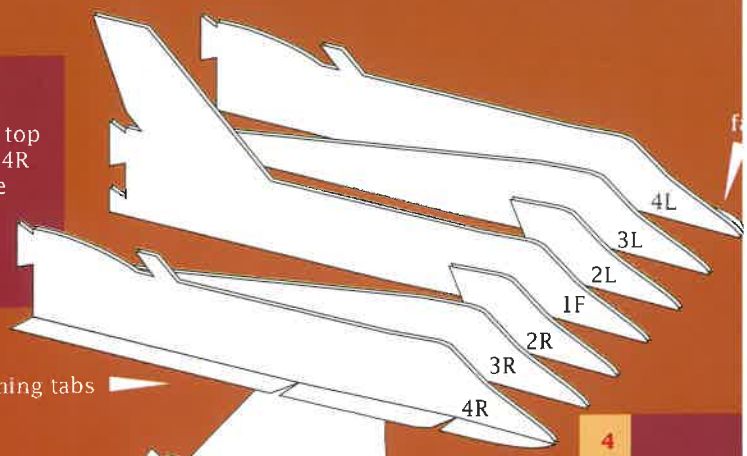
EXPLODED V

1

Photocopy the layout pages of pieces for this model. Then cut out and prepare the parts for assembly. (See the general instructions beginning on p 4.)

2

Bend fastening tabs on top fuselage pieces 4L and 4R and on bottom fuselage pieces 2BL and 2BR.



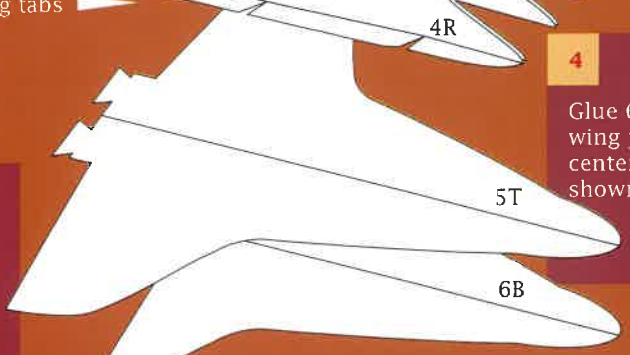
fastening tabs

3

Glue top fuselage piece 1F through 4L and 4R and bottom fuselage pieces 1FB through 2BL and 2BR to build up upper and lower fuselage layers, aligning pieces carefully.

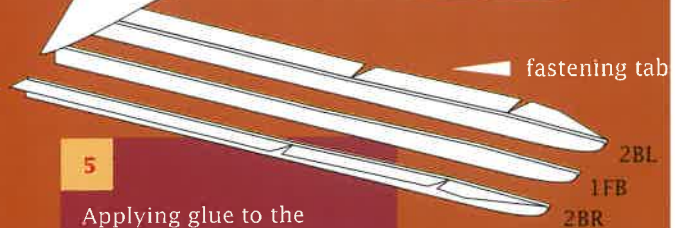
4

Glue 6B to th
wing piece 5
centers. Set
shown below



fastening tabs

fastening tab

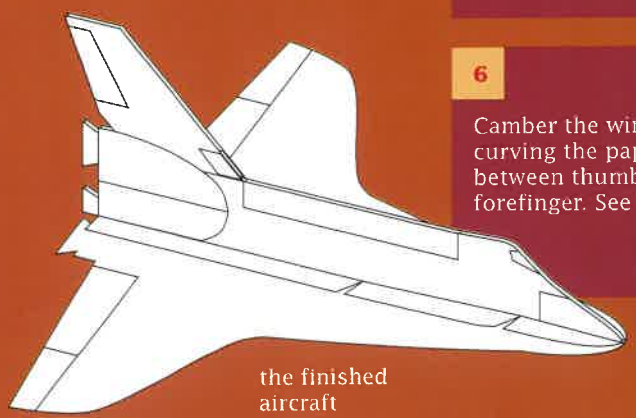


5

Applying glue to the fastening tabs, attach the upper fuselage assembly to the wing assembly, aligning center lines. Repeat with bottom fuselage assembly.

6

Camber the wings by curving the paper gently between thumb and forefinger. See below.



the finished aircraft

camber:
point of maximu
10% from front

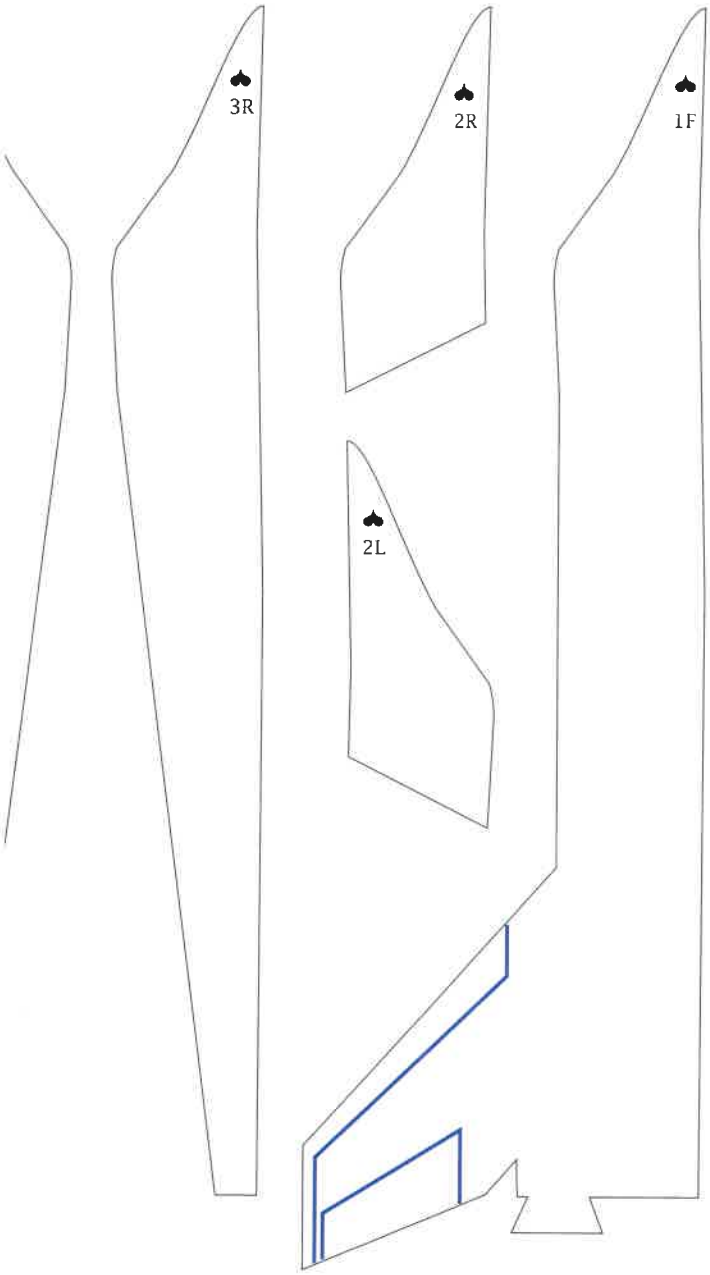
dihedral angle:
wings 3

E PIECES

space shuttle

shown in black.
red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



Space shuttle flights are commonplace today and we forget the incredible accomplishments of this machine. In April of 1981 the first Space Shuttle Orbiter lifted off the launch pad at Cape Canaveral, Florida, marking the beginning of a new era in space travel. Ever since the flights of the X-15 each venture into space required a completely new and expendable vehicle. The Shuttle was designed to be a service vehicle, going back and forth between earth and space, hence its name. Six have been built, which have been used variously to put a great many communications and observation satellites into orbit, as well as the Hubble telescope. Shuttles have been used for on-board experiments, to launch deep space vehicles on their way to other planets, and to recover previously delivered satellites for repairs. More recently they have delivered parts for the construction of the International Space Station.

Shuttle flight is spectacular. Launch takes about 8 minutes, from a vertical position, with the thrust for overcoming the forces of gravity and drag of the 4 million pound (1.8 million km) vehicle coming from two external, solid fuel booster rocket engines together with three liquid fuel rocket engines in the Shuttle itself. The boosters burn for 2 minutes, are jettisoned, and return to earth by

SPACE SHUTTLE PIECES

- Cut on lines shown in black.
- Score lines in red.
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NOTE
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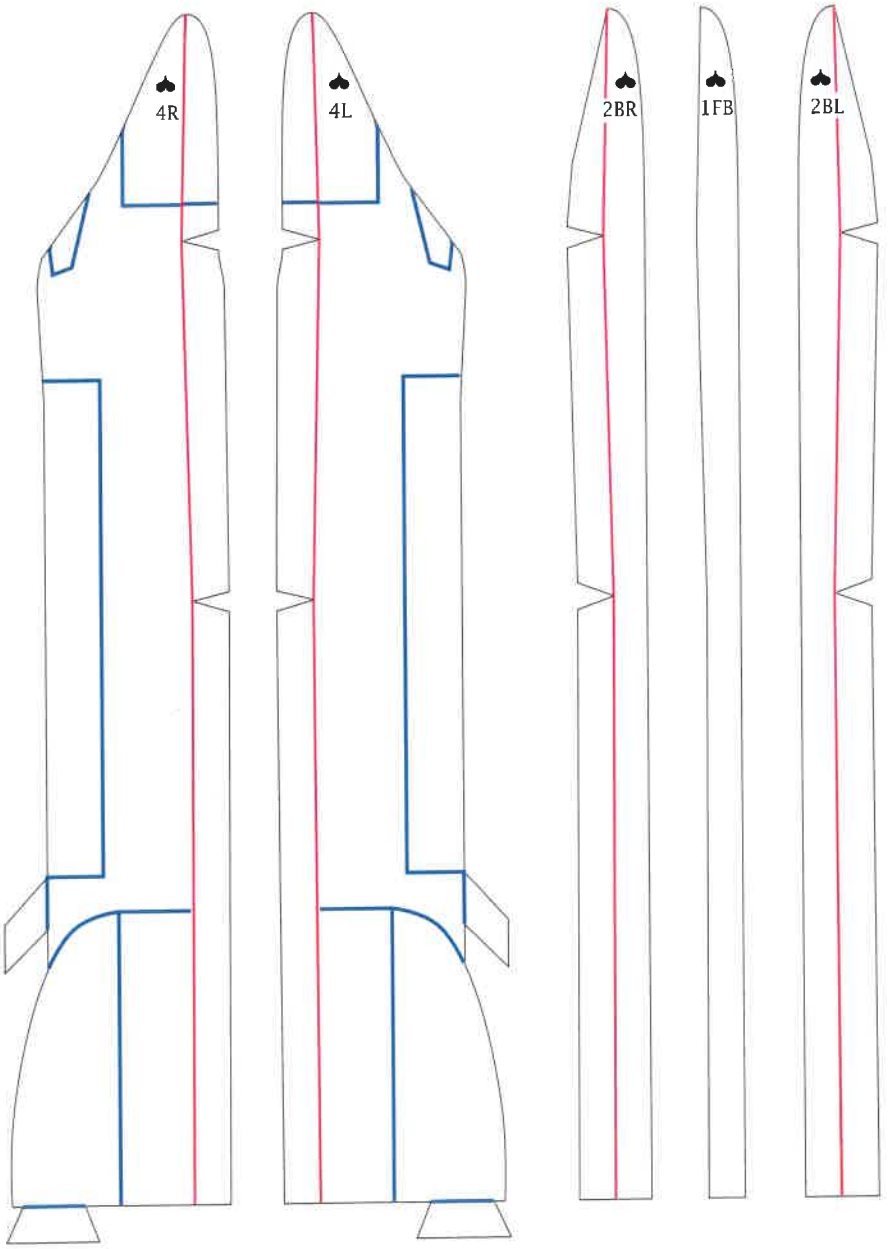


parachute while the ot
engines burn for 8 mir
which time the large e
tank, now empty, drop
burns up as it plumme
The Shuttle, by this tir
traveling at a speed of
mph (27,000 km/h) so
miles (320 km) up, fire
vering engines to posi
earth orbit. While in sp
sunward side is heatec
degrees F (120 degree
shade side is -250 deg
its work in space is co
maneuvering engines
reduce speed. The Shu
scends through the at
slowing down further
of drag which heats its
almost 3000 degrees F
degrees C). Once at ae
speed the Shuttle becc
glider and is flown to
landing.

AERONAUTICAL TE

Aspect ratio The length of a w
width. A square has an aspect ra

Astronauts' wings A qualifica
go into space.

Ailerons Surfaces on the traili
that control roll.

Airfoil A lift-generating surfac

Airframe Those parts of an ai
skin surfaces) that give it the ab

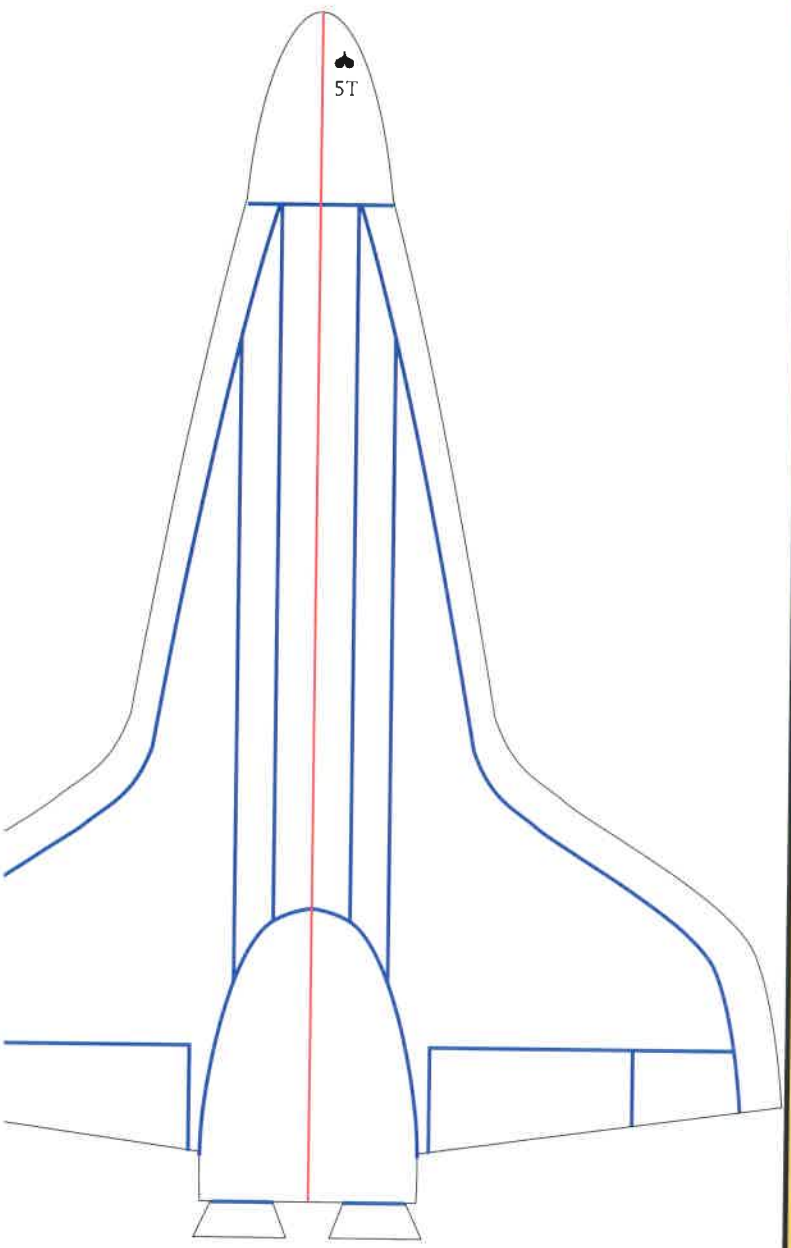
Angle of attack The downwar
to back, of a wing to increase lift

Attitude The roll, pitch, and y
flight, and the direction it is poi
the horizon.

TTLE PIECES

shown in black.
n red.
lines as guides for adding details to the aircraft.
front edge of the piece.

NOTE
CUT OUT PHOTOCOPY ONLY



Banking Raising the outside wing and lowering the inside wing during a turn.

Bird flight A bird's wing produces a lifting force near the bird's body where up and down motion is least and a propelling force with the large feathers at the tip where motion is greatest.

Canard airframe An airplane that has a small wing ahead of its main wing. The elevator, being ahead of the center of gravity, must be angled downward for flight.

Camber The convex curvature of the upper surface of a wing.

Center of gravity The point on an aircraft where its weight appears to be concentrated; its balancing point.

Center of lift The point on an aircraft where its lift appears to be concentrated.

Chord The measurement of a wing from front to back.

Control surfaces Small flat hinged surfaces on the trailing edges of wings and tail used to maintain equilibrium and maneuver an airplane.

Dihedral angle The upward slanting of wings away from the fuselage.

Dirigible A lighter-than-air powered, steerable aircraft, also called an airship.

Drag The resistance of air on moving objects.

Elevator Control surface on the trailing edge of the horizontal stabilizer used to control pitch.

Fly-by-wire Aircraft control surfaces that operate electronically rather than mechanically.

Fuselage The body of an airplane.

Gravity The force of the earth keeping objects on the ground and giving them weight.

High aspect ratio A wing that is very long in relation to its width.

Horizontal stabilizer A flat horizontal surface directs the flow of air in aid of maintaining equilibrium.

Hypersonic Speeds of between 5 and 7 times the speed of sound, 3700-5180 mph (5920-8288 km/h).

Internal combustion engine An engine in which mechanical energy is produced by the explosion of a mixture of fuel and air producing pressure on a piston in a cylinder.

Leading edge The front edge of an aircraft part.

Lift The force generated by the wings that counteracts the force of gravity.

Mach 1 The speed of sound, about 740 mph (1184 km/h).

Maneuver Skilfully making an airplane move in the correct manner and fly in the desired direction.

SPACE SHUTTLE PIECES

- Cut on lines shown in black.
- Score lines in red.
- Use the blue lines as guides for adding details to the aircraft.
- ♠ Indicates the front edge of the piece.

NOTE
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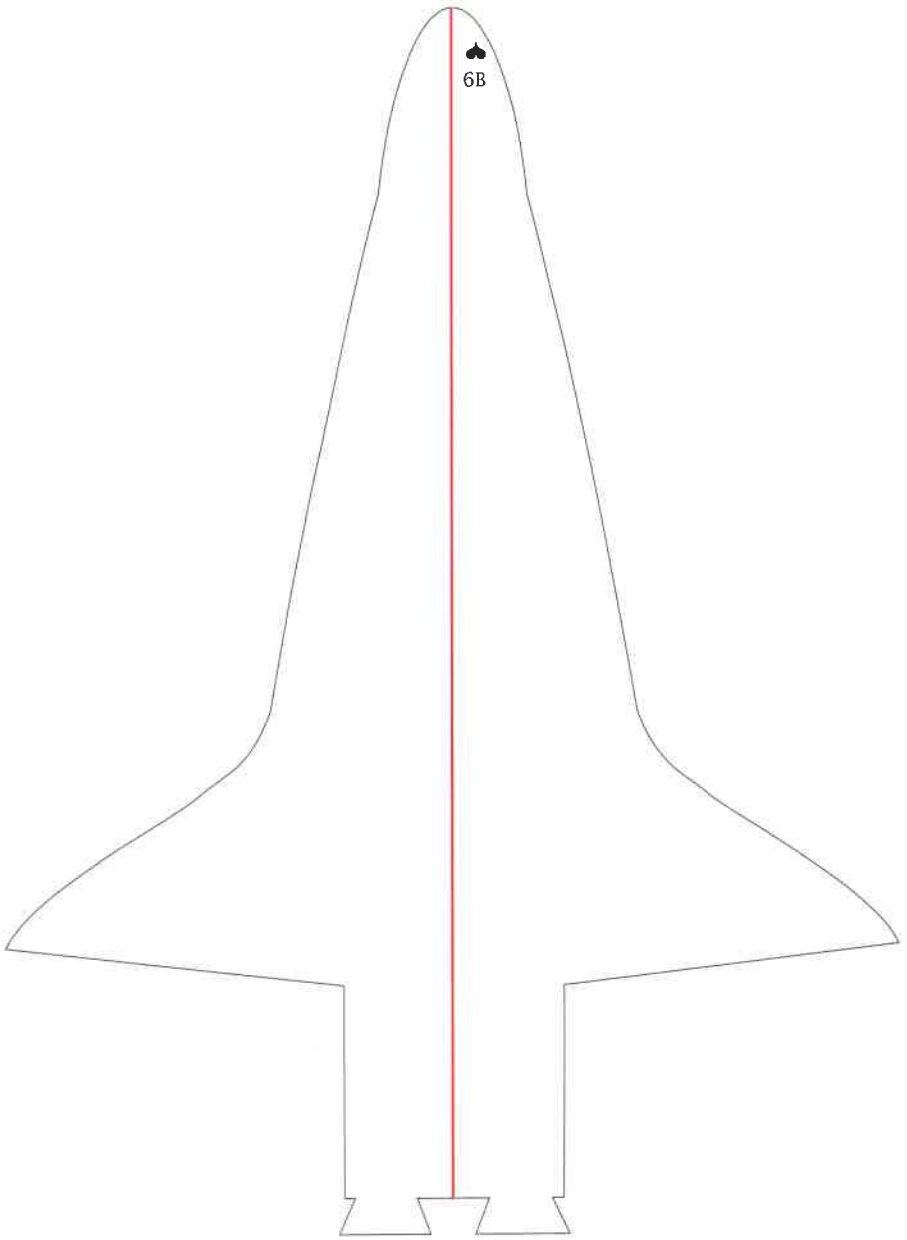

Pitch The rotation of an airplane c
to go up or down.

Roll The rotation of an airplane ca
wingtips to rise or fall.

Rudder Control surface on the tra
vertical stabilizer used to control ya

Shockwave The pileup of sound w
object traveling at the speed of soun

Sonic boom The explosive sound
shockwave being generated by an ai
by at supersonic speed.

Sonic speed (sound barrier) The s
sound waves move through the air.

Stall The condition that occurs wh
angle of attack is too great.

Steam engine An engine that prod
cal energy by the pressure of steam
outside the engine on a piston in a c
the engine.

Strakes Small leading edge wing e
wing root for added lift.

Streamlining Shaping an airframe
flowing around it creates the least a

Supercruise An airplane flying at
speed for an extended time.

Supersonic The speed of an objec
the speed of sound.

Thermal barrier The amount of h
by drag that an airframe can withsta

Thrust The force needed to move
forward.

Trailing edge The back edge of an

Trim The adjustment of control su
an airplane in flight does not roll, pi

Vertical stabilizer A flat vertical
directs the flow of air in aid of maint
equilibrium.

Vortex The air that swirls in a circu
behind each wingtip as air slips fro
pressure area below to the low press

Wing loading The amount of weig
of wing is required to lift.

Wing span The measurement fro
wingtip.

Yaw The rotation of an airplane ca
go left or right.

nning 4
4, 35
ded view, 33
, 34, 35
0, 31

netry, 5

led view, 49
, 50, 51
ets, 74
62
, 3

l view, 19
0, 21
rriage, 20
ll, 20
rld flight,

ngs, 71
ngs, 21

t, 3

led view, 41
, 42, 43
39
Race, 66
mar, 67
l
6
ploded

eces, 38, 39

l
58, 59

d view, 53
54, 55
age, 17
9
62
ge, 5

e, 89
l, 92
rge, 16, 17
dy, 3

center of lift, 3
contents, 2
craft knife, 4
curved wing lifting force, 24
cutting model pieces, 4

Daily Mail prize, 62
decorating, 5
de Razier, François, 43
dihedral angle, 5
dirigible, 44
dirigible exploded view, 45
dirigible pieces, 46, 47
displaying models, 3, 5
display stand, 3
drag, 3, 16

elevator, 3
enclosed fuselage, 20

Father of Aviation, 17
F-4 phantom II, 72
F-4 phantom II exploded view, 73
F-4 phantom II pieces, 74, 75
felt-tipped markers, 5
first living creatures in balloon flight, 43
first manned powered controlled flight, 47
first powered flight, 58
first untethered human balloon flight, 43
flapper, 10, 12
flapper exploded view, 11
flapper pieces, 12, 13
flight basics, 3
free flight, 17

Gatty, Harold, 87
Gee Bee, 64
Gee Bee exploded view, 65
Gee Bee pieces, 66, 67
general assembly instructions, 4
Giffard, Henri, 47
glider exploded view, 15
glider pieces, 16, 17
gliders, 14
gliding flight, 16
global strategic reconnaissance spy plane, 78
glue, 4
gluing, 5
Goodyear Tire and Rubber Company, 54, 55
Gossamer Condor, 9
Granville Bros. Aircraft, 66, 67
Granville Wind Tunnel, 67
gravity, 3
guide sheets, 4
gun armament, 74

harrier, 80
harrier exploded view, 81
harrier pieces,, 82, 83
Hawker Siddeley Company, 82
heavier-than-air machine, 17
helium gas, 51, 54
Henson, William Samuel, 20, 21
high aspect ratio airfoil, 25
home-built aircraft, 38
hot air balloons, 46
human powered flight, 9
hydrogen filled balloons, 46, 47 ,51, 54
hypersonic, 70

index cards, 4
internal combustion engine, 31, 50
introduction, 3

jet power, 39
jet propulsion, 74
Johnson, Kelly, 78

kite-like gliders, 17

Langley, Samuel Pierpont, 29, 30, 31
Leonardo da Vinci, 8, 9
lift, 3, 16
lightweight frame material, 9, 30
liquid fuel rocket engines, 94
Lindbergh, Charles, 63, 66, 87
Lockheed, 78
LZ129 Hindenburg, 51

Mach 1, 70
Mach 2, 75
Mach 3, 79
manually turned propeller, 46
McDonnell Douglas, 74
McGready, Paul, 9
metal framework, 50, 63
microsize aircraft, 38
model helicopter, 16
monoplane, 20, 56
monoplane exploded view, 57
monoplane pieces, 58, 59
Montgolfier, Joseph, 42, 43
mutiplane, 22
multiplane exploded view, 23
multiplane pieces, 24, 25

NASA, 79
National Advisory Committee for Aeronautics, 70
North American Company, 71

oiled silk, 20
Olfa cutting mat, 4
ornithopter, 6, 9
ornithopter exploded view, 7
ornithopter pieces, 8, 9

parachute landing, 94
peddlers, 8
personal sport airplane, 38
Phillips, Horatio, 24, 25, 26
photocopy, 4
piggy back, 70
pitch, 3
Post, Wiley, 87
power engines, 16
powered flight, 16
Pratt and Whitney & pedal operated engines, 79
propeller-driven engine airplanes, 9

reaction thrusters, 71
refuel in flight, 79
remote controlled aircraft, 34
rigid airship, 50
rising hot air, 42
rocket engine, 71
rocket fuel, 71
roll, 3
rudder, 3
Rutan, Dick, 88

scoring model pieces, 4
Second World War, 34, 74
sightseeing blimp, 55
Shuttle flight, 93
Shuttle launch, 93
sky cranes, 55
soaring birds, 9
solid fuel booster rocket engines, 94
Space Shuttle, 90
Space Shuttle exploded view, 91
Space Shuttle Orbiter, 92
Space Shuttle pieces, 92-95
Spirit of St. Louis, 60
Spirit of St. Louis exploded view, 61
Spirit of St. Louis pieces, 62, 63
SR-71 blackbird, 76
SR-71 blackbird exploded view, 77
SR-71 blackbird pieces, 78, 79
steam engine, 30
steam power, 20, 29, 30
steel-edge ruler, 4
stick glue, 4, 5
super alloys, 71
suspended gondola, 47

tandem wings, 27
tandem wings exploded view, 28
tandem wings pieces, 29, 30, 31
Taylor, Moulton, 34, 35
Thompson Trophy Race, 66
Thrust, 3
tiltable ducted fan engines, 55
titanium, 78
Tomahawk Missile Program, 34
transatmospheric, 71
trans-ocean flight, 63
trimming, 3, 5
twin-engine afterburning turbojet, 75

unmanned gliding flight, 17, 25
US Air Force Thunderbirds, 75
Us Navy Blue Angels, 75

vectoring jet nozzles, 82, 83
vertical takeoff, 82
Vickers Vimy, 62
Von Zeppelin, Count Ferdinand, 50, 51
Voyager, 84
voyager exploded view, 85
voyager pieces, 86, 87, 88, 89

white glue, 5
wing flapping, 8, 9
wing flapping machines, 8, 12, 13
wing symmetry, 5
Wright brothers, 29, 31, 58

x-acto knife, 4
x-15 spaceplane, 68
x-15 spaceplane exploded view, 69
x-15 spaceplane pieces, 70, 71

yaw, 3
yeager, Jeana, 88

Zeppelin Foundation, 50

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